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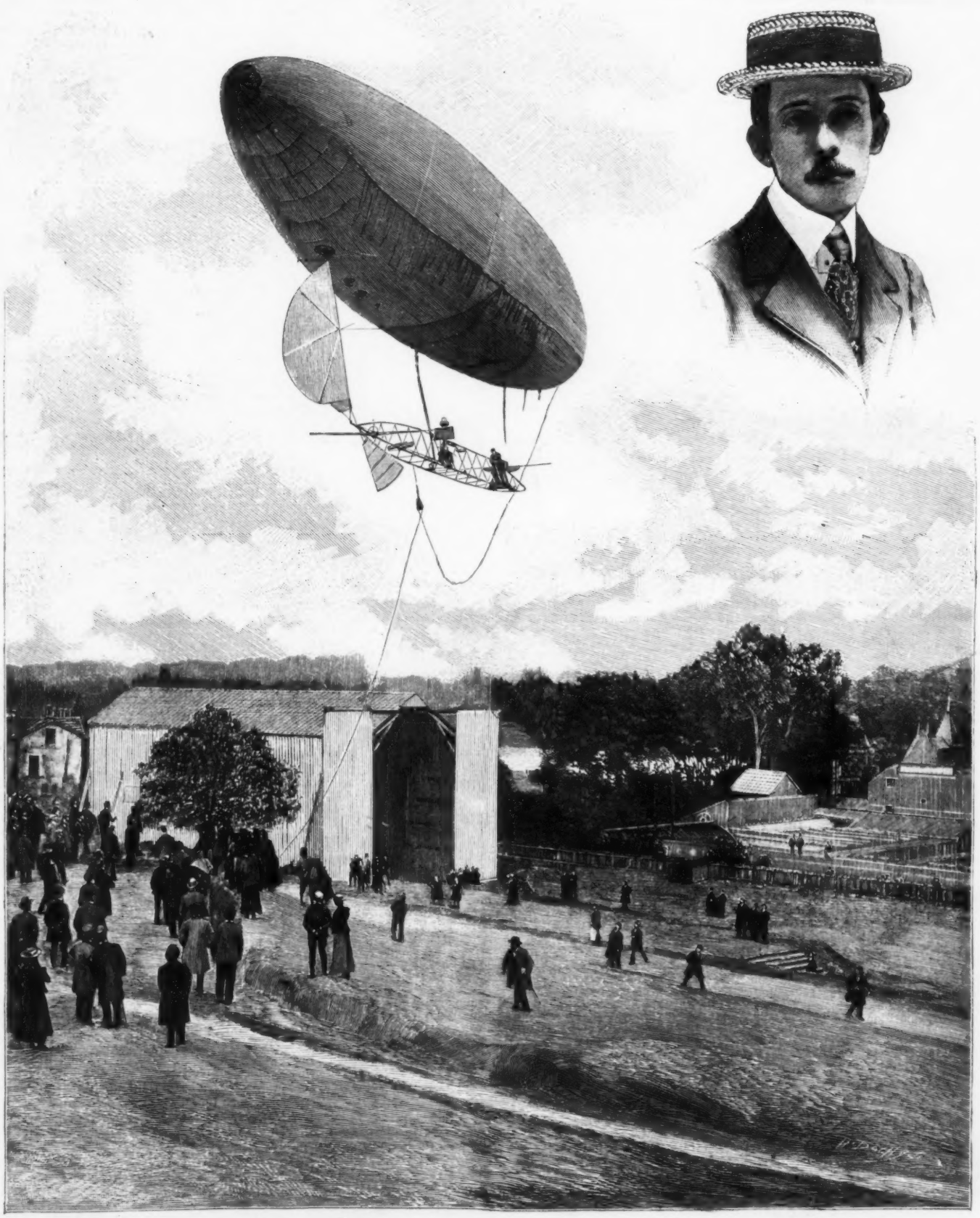


M. SANTOS-DUMONT WINNING THE DEUTSCH PRIZE ON OCTOBER 19—THE DESCENT AT THE AÉRO PARK.

M. SANTOS-DUMONT WINS THE DEUTSCH PRIZE.

THE committee in charge of the distribution of the Deutsch prize decided on November 4 that M. Santos-Dumont was entitled to it by his achievement of October 19. At eighteen minutes to three o'clock he made the start, and in nine minutes the "Santos-Dumont No. 6" had reached the Eiffel Tower on the north side, made a complete turn around it and made for the starting point. Our diagram gives an idea of the course which was followed. At 3:12:40 the guide-rope was seized, and, according to the rules which were recently formulated by the committee, M. Santos-Dumont had lost by forty seconds. He claimed, however, that he had begun his experiments under conditions in which the guide-rope did not figure, and he at once protested against the decision of the judges. The matter was left to a committee, which decided in favor of M. Santos-Dumont on November 5.

He donated 50,000 francs, or one-half of the sum, to the poor of Paris. He then gave 30,000 francs to his assistant, M. Aimé, and the remaining 20,000 francs to the aeronaut's other co-laborers.

While M. Santos-Dumont has performed a notable feat, it does not necessarily follow that he has accomplished anything of very great value. He has demonstrated the fact that with a very costly and delicate apparatus a skillful aeronaut may, under favorable conditions of wind and weather, rise from a given point, make a circle and return to the spot from which he started without being killed, if he has good luck. The event, pleasant as it is, does not, however, mark a step in the direction of the practical realization of aerial navigation. It is probable that the solution of the problem of aerial flight will never be reached in a way which will have any commercial value until the dirigible balloon idea is abandoned and that of a mechanism built on a strictly mechanical basis substituted.—For our engravings we are indebted to L'Illustration.

TOBACCO CULTURE IN HAITI.

UNDER date of September 25, 1901, Minister Powell, of Port au Prince, reports on the progress of tobacco culture and manufacture of cigars in Haiti as follows:

Haiti, situated in nearly the same latitude as Cuba, will soon rival it in its production of fine grades of tobacco. It has a more equable climate, free from cyclones and hurricanes, and a far more fertile soil, which has not been weakened by long-continued cultivation; all that is needed is skilled cultivation and proper curing. It may be said that tobacco culture has now passed the experimental stage and will within a few years become an important source of revenue to this Republic. A new species has been produced by cross fertilization, called the "Diqueney"—after the place where it is grown—said to surpass in many respects the best Cuban grades. This species grows from 5 to 7 feet high, and bears within a few inches from the ground a large, smooth leaf, 20 inches long by 15 inches wide, free from defects. The seed is sown in the latter part of July in well-irrigated beds, which are protected from the fierce rays of the sun by light, raised covers. In September the plants are transplanted into carefully prepared beds of rich, dark, loamy soil, which are also kept plentifully supplied with water. Cutting takes place about three months after planting. Between the latter part of November and the middle of March three cuttings are made; a fourth can be made, but the quality of the tobacco is not so good. The process of curing, upon which the value of tobacco depends, is as follows: The tobacco, after being dried in the drying house, is subjected to a sweating process of from three to four days, dependent upon the weather; the leaves are then stripped from the stems and assorted, after which they are left for one or two months. The tobacco in bales is then placed in a press, holding from 1,500 to 2,000 pounds, for fermentation, where it remains eight or more days, until it reaches a temperature of 136 deg. F.; it is then put in a second press, where it remains fifteen days, until it reaches the same temperature. This operation is repeated six times before it is placed in the last press, where, after being moistened with water, it remains a month. The tobacco is then arranged in large bales and left for two months, when it is made into bales weighing 150 pounds and stored in a dark room for six months.

One factory here, under American-German management, employs a force of skilled Cuban cigarmakers, who are turning out daily many thousands of fine cigars. The output of this plant amounts to $150,000 per month. Fifty per cent of this is consumed at home, 25 per cent goes to Germany, and the remainder to France, England, and Mexico. Owing to the high tariff, no attempt has as yet been made to introduce the cigars into the United States.

ACETYLENE GAS IN GERMANY AND SWEDEN.

IN compliance with a request from the Treasury Department, an instruction was sent, under date of June 4, 1901, to certain Consular officers in Germany and Sweden to report on the uses of acetylene gas. The answers received follow:

GERMANY.

Consul Kehl writes as follows from Stettin:

Acetylene gas is emerging from a crisis which almost retired it as an illuminant. About eight years ago, when this gas was in its infancy, numerous devices for its manufacture sprang into existence; but through ignorance and improper constructions, many fatalities resulted. In December, 1896, an awful explosion of acetylene gas occurred in Berlin. The press denounced its use; the police authorities throughout Germany placed almost prohibitive restrictions upon acetylene generators; the preparing of liquid acetylene was strictly forbidden; insurance companies protected their interests by high rates and special requirements in addition to those prescribed by the police. As a result, only safe and meritorious machinery is now constructed.

The advantages claimed for acetylene gas are many. It is the nearest approach to sunlight, with a power said to be fifteen to twenty times as great as ordinary coal gas, and with six times less heat when used for illuminating purposes.

Factories.—For the manufacture of gas-producing contrivances and the various acetylene-burning devices, Germany has about two hundred and thirty-five factories, the most important being the "Allgemeine Carbid und Acetylen Gesellschaft, Berlin." This concern manufactures everything in the line of acetylene-producing machinery and the different gas-consuming articles.

Marine Lights of Acetylene Gas.—The imperial testing station for marine lights, situated close to Stettin, has officially tested the light-house burner and reflector manufactured by the firm above named. The chief of the station, in a personal interview, expresses himself as follows:

"For lighthouses out of reach of electricity, and easily accessible in winter or summer, acetylene would render good services, although it can in no way be compared with electricity in reliability, on account of the many details which must be looked after when burning this gas. I prefer electricity. Most of the French coast lights are electrical, while our lights are all petroleum."

At the Altenbruch lighthouse, on the Elbe, there have been some experiments with acetylene, giving the following results: By a consumption of 102 liters per hour, 302 candlepower was produced, and by 175 liters per hour, 435 candlepower.

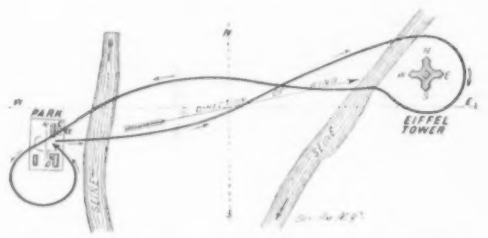
An objection to acetylene for "long-range" lighthouses, as advanced by an experienced sea captain, is that in a fog or thick weather it "walls" too easily. A petroleum light will penetrate a fog to a greater distance than any other illuminant. For clear weather, acetylene probably gives the best results.

In this district (the Oder River down to Ziegenort) there are fifteen navigators' lights, five of which are burning acetylene; one (on an artificial island in the Big Bay) is to be replaced by electricity, due to the difficulty of approach during the period of ice.

Mariners have made considerable complaint about the weakness of the Arconn light (north point of Rügen Island), and it is at this station that the Allgemeine Carbid und Acetylen Gesellschaft expects to erect its first permanent coast light.

Acetylene Light for Military Purposes.—The acetylograph, manufactured by this same concern, is a portable search or signal light, and can be used by day for signaling purposes. This apparatus, carrying its own generator, is mounted on three legs similar to those of a camera.

The hand search light for the hospital or medical corps has a small generator attached to a belt and connected with a reflector by a hose about three feet long



MAP OF M. SANTOS-DUMONT'S JOURNEY.

Commercial and Domestic Usages.—Successful experiments have been made with acetylene as an aid for photographic light, when making time exposures.

Schöusee, a small village in West Prussia, is illuminated with acetylene.

Radenz Castle, at Koschmin, is lighted throughout with this gas. Many other instances can be quoted where acetylene is used for illuminating. In general, it is not believed that it will ever become popular or have great commercial value. The constant care required to prevent accident is an impediment.

SWEDEN.

The following has been received from Consul-General Muir, of Stockholm:

Acetylene gas has been used in Sweden for about ten years, although its practical use was not developed until after the exhibition at Stockholm in 1897.

Experiments have been made with the gas in lighthouses, beacons, etc., but the results have not yet been reported. It has come into practical employment in several railroad stations, as well as in manufactories, churches, and private dwellings.

The largest firms manufacturing apparatus for the production of acetylene gas are the following: Acytelene Aktiebolaget "Koh T. Noor;" Sarverket "Supiex Ideal;" Aktiebolaget Acetylene-gasverk; Hera Prometheus A. G.; Svensson & Co., Acetylene-affär; Nordiska Acetylene Aktiebolaget; "Prinus" Acetylene Gasverk; Svenska Carbid och Acetylene A. B.—all situated in Stockholm.

The manufacturers of carbide used for the production of acetylene gas are: Alby Calcium Carbid fabrik, Alby; Orebro Electriska Akt. Bol. Orebro; Trollhättans Elektriska kraftaktiebolag, Trollhättan; Stockholms Superfosfat Aktiebolag, Stockholm.

The price of carbide is 200 crowns ($53.60) per ton f. o. b. Stockholm or Gothenburg.

The prices for gas works vary widely, but catalogues may be obtained from this office at any time.

Consul Bergh reports from Gothenburg:

I am informed that in this consular district acetylene has not yet come into use in lighthouses, for buoys, or for beacons. It has been decided, however, to try to use it in the small lighthouse or beacon at the entrance to the city of Marstrand, on the west coast, a few miles from Gothenburg.

Acetylene gas is used on several Swedish steamers for the top-light, the side lanterns, and for search lights. It has recently come into use at several railroad stations, and favorable reports have been made. The gas is furthermore used in carriage and bicycle lamps and hand lanterns in factories, and for small cooking and laundry stoves. It is considered that acetylene would also be adapted for lighting large country estates, churches, hotels, etc.

There are in this city two concerns which manufacture the apparatus, but only a few have yet been exported. I have also seen here appliances of foreign manufacture.

Calcium carbide—used for the production of acetylene gas—is manufactured in Sweden. The largest factory in this part of the country is probably the one at Trollhättan, some 50 miles from this city. I am told that calcium carbide is exported chiefly to Hamburg, but also to Japan and adjoining countries. At present the price of calcium carbide is 20 kronor per 100 kilogrammes (about $2.43 per 100 pounds) at the factory.

According to calculations made by the manufacturers of acetylene works, the use of the gas is economical, especially in this country, where petroleum and coal are considered more expensive than in the United States. It is calculated that a factory using fifty lamps at 16 normal candle power each, burning seven hundred and twenty hours per year, would have the following yearly expenses for lighting:

Using petroleum, refined, at present price	$149 97
Using coal gas in common burners	291 85
Using electric incandescent lamps	236 88
Using acetylene gas	125 53

These calculations are based on the average price of gas and electricity and counting calcium carbide at 27 kronor per 100 kilogrammes.

If certain regulations are complied with and the gas works are of a type approved by the insurance companies, the latter do not make any discriminations against persons or business firms who use acetylene.

SELECTED FORMULÆ.

Artificial Egg Oil.—

Yellow beeswax	0.2 kilo
Cacao oil	0.5 kilo

Melt on the water bath and gradually add 9 kilos of olive oil.

Bulletin Board Paint.—Many formulæ have been devised for giving a slate-like surface to wood, some of which are appended.

I.

Shellac	1	pound
Alcohol	1	gallon
Lamp black (fine quality)	4	ounces
Powdered emery	4	ounces
Ultramarine blue	4	ounces

Dissolve the shellac in the alcohol. Place the lamp black, emery and ultramarine blue on a cheese-cloth strainer, pour on part of the shellac solution, stirring constantly and gradually adding the solution until all of the powders have passed through the strainer.

II.

Ivory black	2	ounces
Emery	1	ounce
Ultramarine	1	ounce
Shellac	4	ounces
Alcohol	2	pints

Mix well and agitate until the shellac is dissolved.

III.

Lamp black	1	ounce
Pumice stone	4	ounces
Boiled linseed oil	8	ounces
Turpentine to make	2	pints

IV.

Shellac	8	ounces
Lamp black	1½	ounces
Ultramarine	3¼	ounces
Rotten stone	4	ounces
Pumice stone	4	ounces
Alcohol	4	pints

Dissolve the shellac in the alcohol and add the other ingredients, in fine powder. Shake well before using.

Still another formula may be found in the Circular for July, page 148.

In preparing these paints it is essential that the insoluble substances be reduced to very fine powder and that they be thoroughly incorporated in the mixture, and also that they be kept in a state of suspension during the process of application by constant agitation.

Of course, much depends upon the skill of the painter, for unless he prepares the surface of the board or wall well before putting on the paint the latter cannot be expected to appear to the best advantage. Two coats are usually to be preferred to one, and uneven surfaces after either coat has been applied should be rendered smooth by rubbing with sandpaper or emery cloth.—Druggists' Circular.

BRUSH DISCHARGE THROUGH DIAPHRAGMS.—M. Toepler has noticed some interesting modifications of the "brush-arc" in the open air between a metallic point and a semi-conducting plate, such as slate or basalt. These modifications are produced by introducing a small block of metal or a metallic diaphragm into the path of the discharge. The block or diaphragm becomes an intermediate electrode to a portion of the discharge, whose size varies with the size of the obstacle. As the obstacle is displaced to and fro between the point cathode and the plate, the anode and cathode light immediately adjoining it travel to and fro with it, and so do all the light phenomena between the obstacle and the plate, whereas those between the obstacle and the point retain their positions unless obscured. When brush-arc phenomena are at play on both sides of a diaphragm, it is seen that the latter is always filled with a luminous mass, with its point toward the anode. In the case of a metallic block, the blue cathode light appears on one end of it and the positive glow on the other; but these are absent in the case of the diaphragm. The fact that the shape of the luminous mass in the opening of the diaphragm is the same as that of the ordinary brush-arc discharge, makes it probable that the latter is characterized by alternate widenings and constrictions of the current path.—M. Toepler, Ann. der Physik, No. 10, 1901.

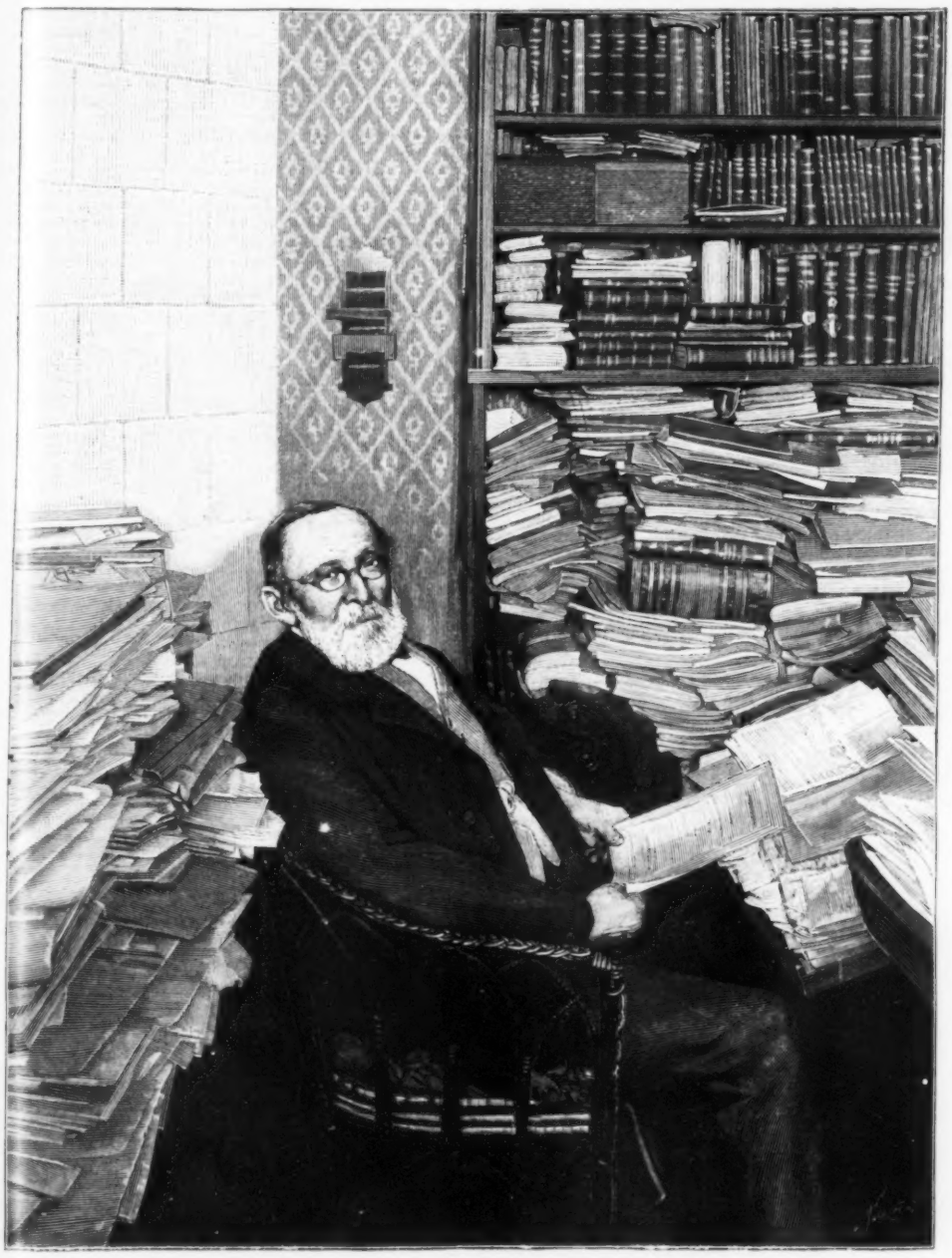
PROF. RUDOLPH VIRCHOW.

PROF. RUDOLPH VIRCHOW, who reached his eightieth year on the 13th of October, is one of the most illustrious scientists of Germany. He was born at Schivelbein, Pomerania, October 13, 1821, and was made doctor of medicine at the age of twenty-two. He was scarcely twenty-six when he was apointed preparator at the University of Berlin, and was shortly afterward commissioned by the government to go to Silesia in order to contend with an epidemic of typhus fever.

If the precocity of his remarkable qualifications presaged a long and fruitful scientific career, the good fortune of becoming distinguished in high places at the beginning of his professional life seemed to promise him a continuous ascent, without mishap or difficulty, of all the steps of the official hierarchy. Of these two probabilities, the first alone was to be realized. In fact, Virchow's ardent passion for science did not absorb him exclusively, for he had in addition a great love for politics, and this second mistress, attended upon concurrently with the other, was an embarrassing "liaison" that thwarted what a functionary or a military man would call his advancement. The movement Parliament at various times, where he stood constantly at the breach battling against the authoritativeness of power, against the excesses of militarism and centralization, and against colonial enterprises. He was a declared adversary of Bismarck, with whom, it is said, he once came near fighting a duel.

It was not till 1892 that Prof. Virchow was appointed rector of the University of Berlin. This dignity, for which so many accomplishments had long designated him, he certainly would not have been made to wait for till the age of seventy-one had it not been for the independence of his political opinions.

Obeying a double vocation, Virchow has realized this extraordinary thing, a prosecution of the cult of science and militant politics with an almost equal passion. Such a case is rare everywhere, for it would seem as if, between these two elements, accidentally united, there were a sort of incompatibility. Virchow's duality is so much the more remarkable in that, in him, the impetuous activity of the politician has in nowise diminished the productive activity of the scientist. As an evidence, take his practical labors and his numerous works, the majority of them classical, and the most important of which, such as "Cellular Pathology Applied to Physiological and Pathological Teaching," have been translated into all languages. Virchow, a reformer, and even a revolutionist, in medicine as well as in politics, a creator and director of institutions founded for the purpose of favoring the progress of medical science, and one of the first propagators of public hygiene, is not solely a national illustration. Without equaling Pasteur, he rightly enjoys renown and the reputation of being a universal authority.—For the above particulars and the engraving we are indebted to L'Illustration.



PROF. RUDOLPH VIRCHOW IN HIS STUDY.

of 1848, the influence of which made itself felt throughout entire Europe, awakened a revolutionary spirit in the young doctor, who founded a democratic club, and performed the part of a tribune in making a furious assault upon the absolute regime. He was elected a representative to the Constituent Assembly, but was unable to take his seat because he had not reached the age of eligibility. He had, however, the satisfaction of witnessing the triumph of his cause. But a reaction supervened, and he fell into disgrace and lost his position, and, for want of something better, accepted a chair in the University of Wurtemburg. In 1856, although he was always in quite bad odor at Court, the brilliancy of his teaching and the increasing popularity of his name forced the hand of the government, and M. de Manteuffel gave up to him his chair at Berlin.

Such vicissitudes, however, did not disgust him with political life. In 1859 the resumption of the liberal movement found him ready for a new campaign. He entered the Municipal Council of Berlin, where he fulminated against the administrative abuses, and was afterward elected deputy by three electoral colleges simultaneously, and became one of the most influential chiefs of the Constitutional opposition and of the progressive party. Before, as well as after, the establishment of the Prussian hegemony, he was sent to

GIGANTIC MAP OF PARIS.

"Up to a year ago," says a Paris dispatch to the London Telegraph, "Paris was the only commune of France which did not possess a gigantic map setting out not only every street of the city, but showing every building and plot of land, with an index as to its owner and value. In October, 1898, the Municipal Council decided to remedy this defect, and the survey has just been completed. Paris, it appears, comprises 88,587 private buildings—that is to say, houses, workshops or edifices belonging to individuals. Of this total, 84 882 are residential properties, 1,316 workshops or manufactories, and 2,389 residences and workshops combined. It is estimated that these 88,587 properties have an annual rental value of $176,000,000 and that the actual value of the edifices is about $4,000,000,000. These totals only refer to the buildings within the fortifications of the city."

ADDRESS IN ECONOMIC SCIENCE AND STATISTICS BEFORE THE BRITISH ASSOCIATION.

THE address in Section F was by Sir Robert Giffen, K.C.B., LL.D., F.R.S., the president, who dealt mainly with the increase of European population during the last century. The growth all round is from about 170 millions at the beginning of the century to about 510 millions (excluding South American countries and Mexico); while the growth of the United States alone is from a little over 5 to nearly 80 millions, and of the English population of the British Empire from about 15 to 55 millions. Germany and Russia also show remarkable growth—from 20 to 55 millions in the one case, and from 40 to 135 millions in the other—partly due to annexation; but the growth of France is no more than from 25 to 40 millions. Without discussing it, we may understand that the economic growth is equally if not more remarkable. The effect necessarily is to assure the preponderance of European peoples among the races of the world—to put aside completely, for instance, the nightmares of yellow or black perils arising from the overwhelming mass of yellow or black races, these races by comparison being stationary, or nearly so. The increase of population being continuous, unless some startling change occurs before long, each year only makes European preponderance more secure. Equally it follows that the relative position of the British Empire, the United States, Russia, and Germany has become such as to make them exclusively the great world powers, though France, for economic reasons, notwithstanding the stationariness of its population, may still be classed among them.

SPECIAL POSITION OF BRITISH EMPIRE.

Another idea which follows from a consideration of the same facts is the necessity laid upon the British Empire to consolidate and organize itself in view of the large additions of subject races made to it in the last century, and especially in the last twenty years of the century. In a paper which I read before the Royal Colonial Institute two years ago, an attempt was made to show that the burden imposed on the white races of the Empire by these recent acquisitions was not excessive as far as the prospect of internal tumults was concerned. Relatively to some other Powers, especially France, we have also been gaining internationally in strength and resources. But whether we had gained internationally on the whole, looking at the growth of Powers like Russia, the United States, and Germany, and their greater activity in world-politics, was a different question. The problem thus stated remains. It would be foreign to the scope of an address like this, which must avoid actual politics, to examine how far light has been thrown on it by the South African war. No one can question, at least, that the organization of the Empire must be governed by considerations which the international statistics suggest, and that no step can be taken safely and properly unless our public men fully appreciate the ideas of international strength and resources as well as other considerations which are germane to the subject.

EUROPE AND FOREIGN FOOD SUPPLIES.

Another idea to which attention may be drawn appears to be the increasing dependence of European nations upon supplies of food and raw material obtained from abroad. We are familiar with a conception of this kind as regards the United Kingdom. For years past we have drawn increasing supplies from abroad, not merely in proportion to the growth of population, but in larger proportion. The position here obviously is that, with the industries of agriculture and the extraction of raw material (except as regards the one article, coal) practically incapable of expansion, and with a population which not only increases in numbers, but which becomes year by year increasingly richer per head, the consuming power of the population increases with enormous rapidity, and must be satisfied, if at all, by foreign imports of food and raw materials; there is no other means of satisfaction. But what is true of the United Kingdom is true in a greater or less degree of certain European countries—France, the Low Countries, the Scandinavian countries, Austria-Hungary, Italy, and Germany. Especially is it true in a remarkable degree of Germany, which is becoming increasingly industrial and manufacturing, and where the room for expansion in agriculture is now very limited. We are accustomed, and rightly so, I think, to consider naval preponderance indispensable to the safety of the Empire, and especially indispensable to the safety of the country from blockade, and from the interruption of its commerce, which would be our ruin. But our position in this respect is apparently not quite exceptional. Less or more, our Continental neighbors, and especially Germany, are in the same boat. If preponderance is to be nearly as essential to Germany as it is to this country, who is to preponderate? What our practical action ought to be in the premises is a question that might easily lead us too far on an occasion like this, but the facts should be ever present to the minds of our public men. We may be quite certain that they are quite well known and understood in the councils of the Russian, German, French and other Continental governments.

NEW POPULATION AND NEW MARKETS.

Another idea suggested by the facts appears to be an answer to the question as to how new markets are to be found for the products of an increasing population—a question which vexes the minds of many who see in nothing but foreign trade an outlet for new energies. The point was mentioned in my address at Manchester a year ago, but it deserves, perhaps, a more elaborate treatment than it was possible then to give it. What we see, then, is that not only in this country, but in Germany and other Continental countries, millions of new people are, in fact, provided for in every ten years, although the resources of the country in food and raw materials are generally

used to the full extent, and not capable of further expansion, so that increasing supplies of food and raw material have to be imported from abroad. How is the thing done? Obviously the main provision for the wants of the new people is effected by themselves. They exchange services with each other, and procure the major part of the comforts and luxuries of life which they require. Hence, when additions to the population, and how they are to live, are considered, the answer is that the additions will fill up proportionately the framework of the various industries already in existence, or the ever-changing new industries for home consumption which are always starting into being. These are the primary outlets for new population even in old countries like the United Kingdom and Germany. Of course, active traders and manufacturers, each in his own way, are not to take things for granted. They must strive to spread their activities over foreign as well as over home markets. But looking at the matter from the outside, and scientifically, it is the home and not the foreign market which is always the most important.

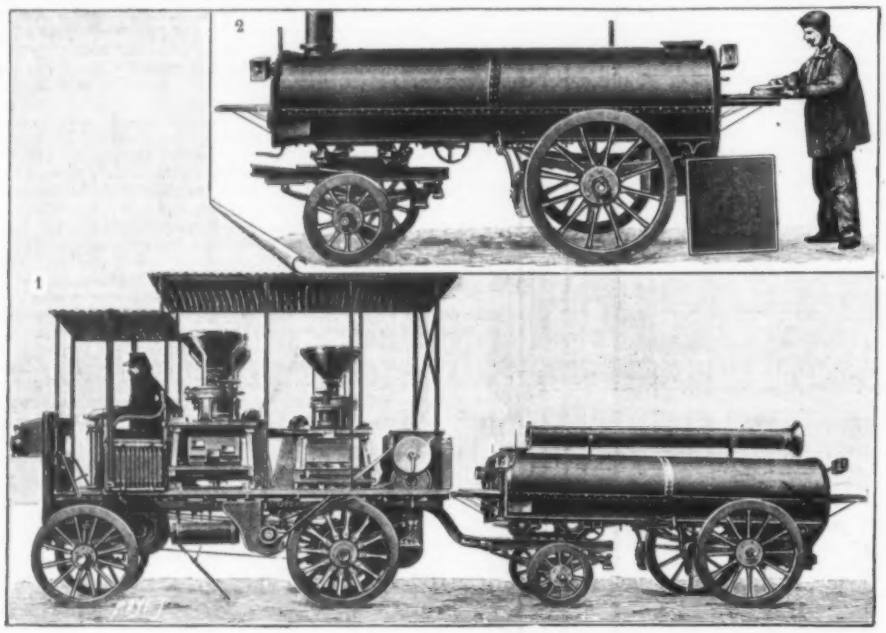


FIG. 1.—A SCHWEITZER BAKERY AUTOMOBILE EN ROUTE. FIG. 2.—THE OVEN IN OPERATION.

DECLINE IN RATE OF GROWTH OF POPULATION.

I come now to another idea appearing on the surface of the census returns when they are compared for a long time past, and the connected returns of births, marriages, and deaths, which have now been kept in most civilized communities for generations. Great as the increase of population is with which we have been dealing, there are indications that the rate of growth in the most recent census periods is less in many quarters than it formerly was, while there has been a corresponding decline in the birth-rates; and to some extent, though not to the same exteat, in the rate of the excess of births over deaths, which is the critical rate, of course, in a question of the increase of population. The United States naturally claims first attention in a matter like this, and it is quite plain that something has happened in the United States to diminish the rate of increase of population after 1860. The Civil War of the early '60's naturally occurs to one as the explanation of the break immediately after 1860, but the effects could hardly have continued to the present time, and a more general explanation is suggested. Other special explanations have occurred to me as partly accounting for the change. One is that, prior to 1860, the United States at different times increased its territory and population partly by purchase and partly by annexation. But I cannot make out that either the purchase of Louisiana early in the century, or the subsequent annexations following the Mexican war would make a material difference. Passing from the United States, we meet with similar phenomena in Australasia. The decline there in the rate of increase is so great and palpable as to need no comment. The decrease here at home is similar, though not so marked. These diminutions in the rate of growth of large populations are corroborated by a study of the birth-rates, and of the rate of the excess of births over deaths. We have thus on one side a manifest decline in the rate of growth of population in three large groups of population, coupled with a large decline of birth-rates in England and Australasia where the facts are known, and a smaller decline in the rate of the excess of births over deaths, this decline in England as yet being comparatively small. Such facts cannot but excite inquiry, and it is an excellent result of the use of continuous statistical records that the questions involved can be so definitely raised. As I have stated, it would be foreign to the object of this paper to discuss fully the various questions thus brought up for discussion, but one or two observations may be made having regard to some inferences which are somewhat hastily drawn. 1. The rate of growth of population of the communities may still be very considerable, even if it is no higher than it has been in the last few years. A growth of 16, 15, or even 12 per cent in ten years, owing to the excess of births over deaths, is a very considerable growth, though it is much less than the larger figures which existed in some parts forty or fifty years ago. 2. Some of the rates of growth of population from which there has been a falling off of late years were obviously quite abnormal. I refer especially to the growth in Australasia between 1850 and 1880, and the growth in the United States prior to 1860. They were largely due to the indirect effect of immigration which has been already referred to. 3. It is also obvious that one explanation of the decline in birth-rate, and of the rate of the excess of births over deaths, may also be the greater vitality of the populations concerned, so that the composition of the population is altered by an increase of the relative numbers of people not in the prime of life, so altering the proportion of the people at the child-producing ages to the total. 4. There remains, however, the question which many people have rushed in to discuss, viz., whether the reproductive power of the populations in question is quite as great as it was fifty or sixty years ago. We have already heard in some quarters, not merely that the reproductive energy has diminished, but suggestions that the populations in question are following the example of the French, where the rate of increase of the population has almost come to an end. Apart, however, from the suggestions above made as to the abnormality of the increase fifty or sixty years ago, so that some decline now is rather to be expected than not, I would point out that the subject is about as full of pitfalls as any statistical problem can be, for the simple reason that it can only be approached indirectly, as there have been no statistical records over a long series of years showing the proportion of births to married women at the child-producing ages, distinguishing the ages, and showing at the same time the proportion of the married women to the total at those ages. 5. One more remark may, perhaps, be allowed to me on account of the delicacy and interest of the subject. To a certain extent the causes of a decline in reproductive energy may be part and parcel of the improved condition of the population, which leads in turn to an increase of the age at marriage, and an increase of celibacy generally through the indisposition of individual members of the community to run any risk of sinking in the scale of living which they may run by premature marriage. These causes, however, may operate to a great extent upon the birth-rate itself without diminishing the growth of population, because the children, though born in smaller proportion, are better cared for and the rate of excess of births over deaths consequently remains considerable, although the birth-rate itself is low. The serious fact would be a decline of the rate of the excess of births over deaths through the death-rate remaining comparatively high while the birth-rate falls. It is in this conjunction that the gravity of the stationariness of population in France appears to lie. While the birth-rate in France is undoubtedly a low one, 21.9 per 1,000 in 1899, according to the latest figures before me, still this would have been quite sufficient to insure a considerable excess rate of births over deaths, and a considerable increase of population every ten years if the death-rate had been as low as in the United Kingdom—viz., 18.3 per 1,000. A difference of 3.6 per 1,000 upon a population of about 40 millions comes to about 150,000 per annum, or 1,500,000 and rather more every ten years. In France, however, the death-rate was 21.1 per 1,000, instead of 18.3, as in the United Kingdom, and it is this comparatively high death-rate which really makes the population stationary. The speculations indulged in in some quarters, therefore, though they may be justified in future, are hardly yet justified by the general statistical facts.

A MILITARY BAKERY AUTOMOBILE.

M. SCHWEITZER, the inventor of some remarkable milling apparatus, has recently devised a flour mill and bakery automobile designed to follow regiments on a march and to make fresh bread every hour with flour ground from wheat obtained by requisition upon the spot.

This vehicle is formed of two parts after the manner of artillery carriages. The first comprises the motor as well as a battery of mills with their bolters and, alongside of them, the mechanical kneading troughs. All these apparatus are actuated by the motor that is employed to propel the vehicle. A continuous oven is hauled in the rear.

The wheat emptied into the mill hoppers is quickly converted into flour, and the bran obtained may be used for feeding the army horses.

As for the flour, that is put into the kneading troughs, mixed with salted water, and then, after fermentation, is formed into loaves, which are placed in the oven. In this way, after the beginning of operations, 240 pounds of bread per hour are obtained, say, food for 5,000 men a day.

All the apparatus of the Schweitzer system—mills, kneading troughs, and ovens—are so simple and so easily managed as to require the employment of no special workmen to operate them. To these advantages is added that of obtaining a bread that has been recognized by chemists and physicians as richer in nitrogenous and phosphated substances, and consequently in the principles necessary for vital energy, than the bread of ordinary bakeries.

The present army ovens are wholly inadequate. As they are established upon the same principle as the ordinary ovens of city and village bakeries it is necessary, in order to prevent a loss of heat, to give them very large dimensions, and to arrest the baking from time to time in order to reheat them. With the Schweitzer continuous oven such inconveniences disappear. The oven is small, and the heat that it receives from the furnace permits it to preserve a constant temperature. The bread enters at one extremity and makes its exit at the other without any interruption in the baking, so that one Schweitzer oven of half the weight of an ordinary one furnishes twice as much bread as the latter in the same space of time.

Upon the whole, the flour mill and bakery automobile under consideration marks a great progress and solves the problem of the feeding of troops on a campaign in the most perfect manner. But such an application is not the only one, since the new apparatus may be employed also with advantage in the execution, in desert countries, of important works that necessitate the concentration of a large number of laborers at various points, such as a great railway like the Trans-Siberian, or a long canal like the Interoceanic.—For the above particulars and the engravings we are indebted to La Nature.

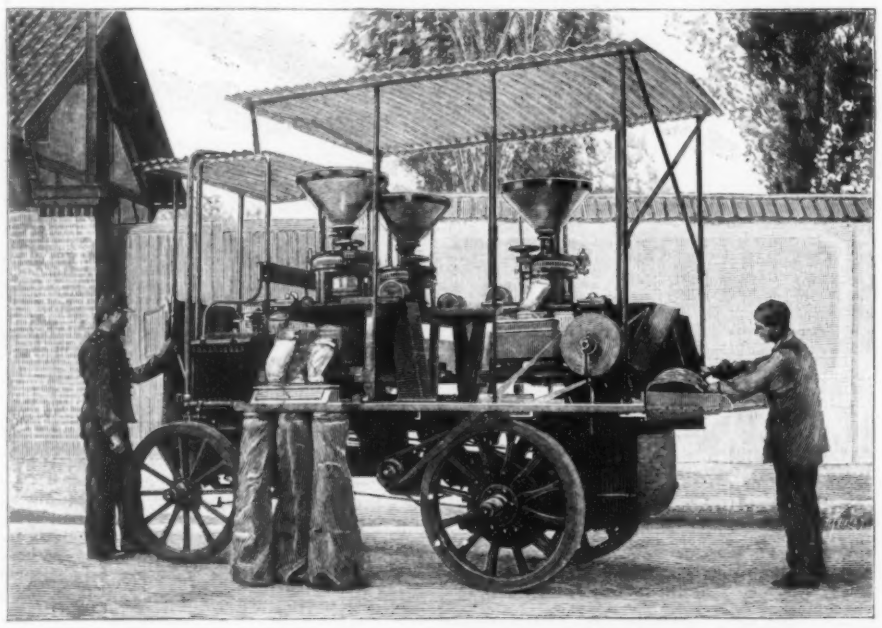


FIG. 3.—THE FLOUR MILL AND BAKERY IN OPERATION.

MODERN GERMAN FIRE ENGINES.

GERMANS have appreciated the difficulty of rapidly getting up steam in fire engines, and have endeavored, within certain limits, to substitute for the steam engine a benzine or gasoline motor. It is of the utmost importance to set the pumps in motion as quickly as possible, and this end the benzine motor would seem to attain with considerable facility. According to Glaser's Annalen, not more than a minute is required to start such a motor. Moreover, the benzine fire engine is most easily attended to, only one man being required. At the present time, however, the steam fire engine dominates the field; but the few benzine engines exhibited at the Paris Exposition show that of the new rival which has entered the field much may be expected.

The largest of the motor benzine fire engines exhibited at Paris is represented herewith, and was made by the Feuerwehrgeraethefabrik von C. D. Magirus of Ulm. The motor is a two-cylinder Daimler engine of 12 to 15 horse power, and is mounted above the rear axle. Not until the hose connections have fully been made are the motor and pump thrown into gear. The pump itself has three cylinders with plunger pistons, and has a maximum capacity of 200 gallons per minute. A special connection has been provided so that four lines of hose, each of about two inches in diameter, can be used. The distance to which a stream is thrown varies from 115 to 164 feet, depending upon the number of hose lines in use. The consumption of benzine, it is said, does not exceed 1½ gallons per hour.

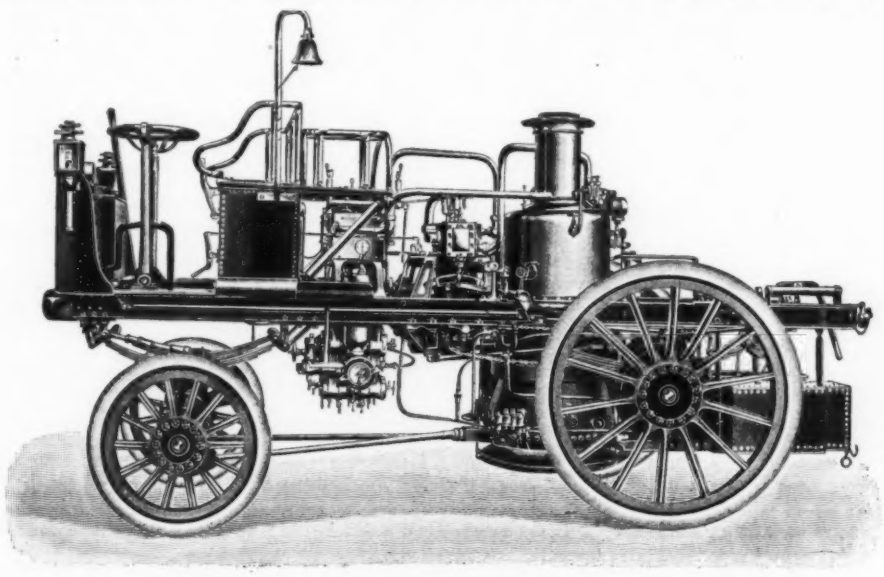
Horse-drawn electrical fire engines were represented at the Exposition by two modern vehicles. Both engines were driven by direct current (without the use of accumulators) and are, therefore, limited in their scope of action. But for extensive plants where electrical power is everywhere at hand, these fire engines should prove of extreme service, especially when it is considered that they can be immediately set in motion.

In the electric motor fire engine built by Wagenbauanstalt und Waggonfabrik vorm. W. C. F. Busch, Bautzen, the motor is mounted in the middle of the vehicle and is geared to a two-cylinder pump mounted directly behind the motor. In the fire engine made by Heinrich Kurtz, of Stuttgart, a triple-cylinder pump is used, and the motor is mounted on the end of the vehicle. The transmission mechanism is exactly the same as in the previous case.

The firm of W. C. F. Busch has likewise designed and built gas motor fire engines, the merits of which are the same as those of the benzine fire engine. The gas fire engine is provided with a horizontal water reservoir of 150 gallons capacity and with two carbonic acid cylinders mounted behind the water reservoir. Each carbonic acid cylinder is provided with a safety valve and gage, and with a cock which can be connected with a hose leading to the engine. The reservoir is provided with two water gages; one hose connection, which serves to fill the reservoir as well as to conduct the compressed gas from the cylinders; one pressure gage; one safety valve; and one drain cock at the bottom of the reservoir.

The fire department of the city of Hanover is equipped with an automobile fire engine which is worthy of some notice. For the purpose of propelling the entire vehicle, an independent reversible twin steam engine is used, which is mounted in front of the pump within the wagon frame. The crank-shaft of the motor is connected with the driving-axle by means of sprocket-and-chain gearing. The speed is regulated by means of a lever mounted in front of the driver's seat. A steering-wheel is likewise carried on the front platform for the purpose of guiding the engine. Fuel and water reservoirs of unusual capacity are provided for both the driving engine and the pump.

It has been already remarked that a certain time must elapse before the ordinary steam fire engine is ready for service. Usually steam is gotten up during the journey to the fire. The steam automobile fire engine is more or less crippled by the fact that without a certain initial pressure it cannot be started at all. For that reason time is lost before the propelling engine can start the vehicle. The city of Hanover has endeavored to save the time which is thus lost by sending out at each hurry call a carbon dioxide gas fire engine which is used on the first attack. The automobile steam fire engine relieves the gas fire engine as soon as possible.

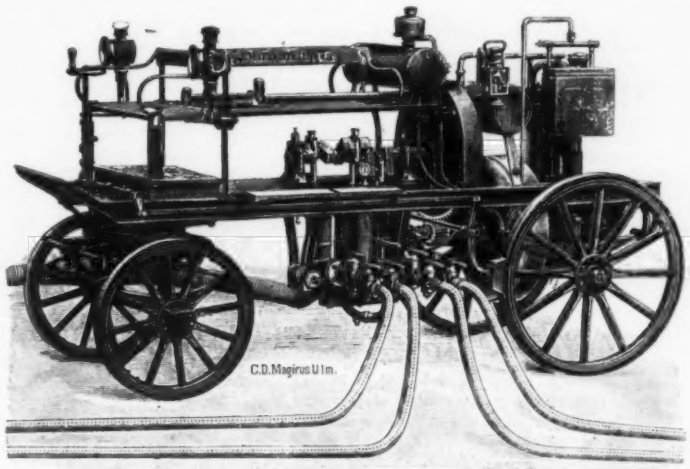


THE AUTOMOBILE STEAM FIRE ENGINE OF THE CITY OF HANOVER.

FACTORS OF SAFETY.*

By ROBERT HENRY SMITH, Assoc. M. Inst. C. E.

UNTIL more intelligent methods than are at present prevalent are introduced to determine the proper values of the factors of safety to be used in designing dimensions, all refinements of scientific theory must remain quite futile. Indeed, within at any rate a limited range of practice, it would hardly be incorrect to say that in the average practice of European engineers the uncertainty of the value of the factor of safety used is such as to swamp entirely the utility of any scientific calculation of sections, whether the calculation be refined or only roughly approximative. One's opinion as to the proper factor to use is, as it ought to be and must be, founded on experience. But the experience usually referred to is special and personal, and, therefore, apt to be delusive. The general widespread experience of the profession is not chronicled with sufficient accuracy; or rather, perhaps, the chronicles are not analyzed with sufficient care to make that experience available for the determination of the proper factors suitable for different circumstances in any authoritative manner. The result is that in precisely the same circumstances different engineers might adopt factors of safety varying from each other by as much as 100 per cent, say, anything between 3 and 6, or between 4 and 8. That being so, it is clear that the result is uncertain to the same extent. The designer could frequently guess a suitable dimension without troubling himself about any calculation with as great accuracy as he can guess the factor of safety by which he has to multiply his theoretically calculated result; and accordingly he does frequently adopt this short cut toward the desired goal.



MAGIRUS BENZINE-MOTOR FIRE ENGINE.

A common idea is that factors of safety are simply allowances for uncertainty as to the quality of the material used, but it is quite clear that a four or five-fold factor would be an irrationally large allowance to make on this account. If there is the smallest possibility of the strength of the material being only one-fifth of what it is supposed to be, there can be no doubt that on that very account the material is quite unfit for use in work where safety of life or property is concerned.

The most extraordinary application of a factor of safety that has come under the author's notice is that used along with Euler's formula for the strength of a long strut, viz.:

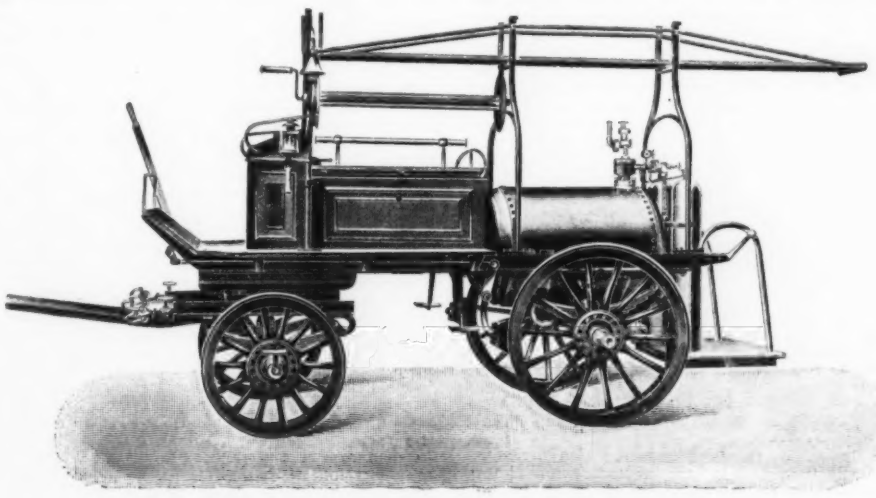
$$\text{Load} = \pi^2 \frac{EI}{L^2}$$

The—mistaken—theory shows that this load will not produce any buckling deflection; but, as practice and experiment show that it not only produces large deflection, but also breaks the strut, a very large factor of safety has to be used. As the modulus of elasticity is the only quantity in the formula about which there is any doubt, this means making allowance for the "possibility"—which practice and experiment would show to be a certainty if the formula were correct—of the modulus of elasticity being only one-sixth or one-eighth of what it is imagined to be.

It seems to the author that even ordinary individual experience is quite sufficient to determine factors of safety within far narrower limits than are generally imagined, if only the definite meanings of these factors and the reasons that compel the use of much larger sections than result from so-called theoretical calculation be distinctly understood.

Factors of safety are ratios in which pieces are made stronger than is required by calculation, according to the theory of strength employed, in order to allow for various kinds of uncertainty as to the exact value of the data, and to allow also for corrosion and abrasion. Sometimes uncertainty arises from doubt as to the legitimacy and theoretic accuracy of the formula or mode of calculation employed. This element of uncertainty would not exist if the method of calculation agreed closely with a theory of whose completeness and accuracy we were quite sure. Many formulas are employed, however, in which niceties and difficulties of theory are confessedly, and indeed, very often deliberately, left out of consideration. Very often the calculation is made on the assumption of uniform distribution of stress over the section, when it is well known that the stress varies largely from side to side of the section. In sections through joints of all kinds in machinery such large deviation from uniformity exists—sometimes the maximum stress is

* Abstract of Presidential Address, Civil and Mechanical Engineers' Society.



BUSCH CARBONIC ACID GAS FIRE ENGINE.

three times the average. The theoretic estimates that have actually been made of this deviation are doubtful in respect of accuracy, and, in any case, are very seldom made use of, or even known by the practical designer. In many sets of circumstances such as these, and occurring most largely in connection with machinery, a very considerable part of the "factor of safety" found to be necessary is evidently attributable to the wrongness of the theory, which is the base of the formula. In many cases the theory or formula is known to be wrong, or, at least, incomplete; but it is not known in what degree its results differ from the true results. In other cases the incorrectness of the formula is not suspected by the man who uses it. Whether or not this be so evidently depends upon the amount of scientific and practical education that the user has received in the colleges and in works.

Here it might be well to note that none of us have as yet received so complete an education that we can always feel quite reasonably secure against an error of judgment as to the absolute reliability of any particular theory. But the important point to notice is that in cases in which it is desirable to adopt a formula as the standard for the practice of a profession, that formula must of necessity base itself upon the knowledge possessed by the average member of the profession. Thus there will be inevitably applicable to such a formula a factor of safety which includes compensation for the average ignorance of the profession. This average ignorance may be so different in Germany, France, England, and America that different formulas rule the practice of these different countries, and correspondingly different factors of safety may be quite proper in these different parts of the world. But there are numberless details of design not settled by any series of rules which it is incumbent to impose upon a whole profession or trade. Then comes in the greater or less accurate theoretical knowledge of the individual designer. If one man designs merely in proportion to the average stress, he must use a larger factor of safety than is properly used by a man who takes the trouble to search out the variation of stress across the section, and makes allowance for it in his theoretic calculation.

Thus, probably, a part of the whole factor used is due to the doubtfulness or ascertained defectiveness of the theory embodied in the calculation, and the ratio representing compensation for this must vary vary largely with a number of conditions which are external to the physical nature of the problem itself.

Beyond this theoretic doubt there remain two chief kinds of uncertainty in the data: First, that with regard to the maximum load to be borne; and, second, that with regard to the quality of the material employed. Thus the ordinary factor is really the resultant of four component factors, and it appears to me that it would conduce very greatly to accuracy and rational consistency if these four factors or allowances were always dealt with separately. Only confusion and error arise from combining them into one multiplier. First, allowance for defectiveness of theory has already been fully discussed.

Second, corrosion and abrasion. Only certain classes of pieces are exposed to these deteriorating actions, and those that are exposed to them are only affected on their surfaces. The surfaces of finished machinery used indoors, such as engines, machine tools, shafting, are not exposed to corrosion if they are properly cared for, and no allowance on this account need be made in designing their dimensions. In many cases the frictional wear of working surfaces of machinery (this being simply slow abrasion) has to be taken into account in designing. This is constantly done in dimensioning brass bearings, and it ought to be done in determining the diameters of piston rods and valve rods, which are frequently taken out to be re-turned true.

Abrasion is, perhaps, a more important consideration in rails and in tires of locomotive and carriage wheels than in any other case. It is also of great importance in ropes and cables, whether these be of hemp or wire, and to whatever use they be applied, provided their use involves their moving. Suspension bridge cables are abraded by wind and rain to a very slight extent. The insides of locomotive and other boiler tubes are abraded by the flame currents. The dust and ash carried along with the flame is well known to have this destructive effect, which in some cases is serious.

The burning of firebox plates and tubes comes under the head of corrosion. So far as the author knows this is the only case in which there is any doubt as to the advisability of making an allowance for oxidation where it is known that oxidation certainly occurs. American experience seems to show that thickening the plates increases the temperature of their surfaces on the flame side, and thereby increases the amount of burning to such a degree that the plates last the longer the thinner they are made, down to the limit consistent with strength to resist the steam pressure. It is, however, an absolute necessity to allow for corrosion on the inside surfaces of boiler plates. From 1-16 inch to ¼ inch should be allowed on the inside surface. Plates are frequently found corroded quite 3-16 inch deep; pitting is often allowed to proceed to a depth of 5-16 inch before patching or other repair is carried out; but no good boilermaker will approve of such practice.

All exposed surfaces of bridge work are also liable to corrosion by atmospheric impurities, and by the evaporation of rain water, and allowance must be made for this in designing dimensions. The allowance to be made here depends upon what it is intended to do in respect of periodic painting.

These corrosive and abrasive actions affect the surface only, not the interior of the section. No factor of safety proper, therefore, can be used to make these allowances. The section is not to be made greater in a constant ratio for large and small sections and for different shapes of section. An extra surface layer of material is to be provided, the thickness of which should be judged of from the special circumstances of each case, and which should vary little, if at all, with the size of the section. Thus the ratio in which the section is increased is less the larger the section is, and is less also the smaller the ratio of the periphery to the area of the section. A less proportionate increase of area is necessary for circular and square sections than for others. As example, ⅛ inch thickness wrapped round a flat section ½ inch by 1¼ inches, increases it in the ratio 1:8; but the same added thickness round a 1½ inch by 3½ inch section enlarges it in the ratio 1:25 only.

Third, uncertainty of quality of material. If the piece is calculated for strength only, the quality, the uncertainty of which is to be allowed for, is the breaking stress or the stress at the "limit of elasticity." For the purpose of strength calculation the best definition of the "limit of elasticity" seems to be the "maximum stress the material will bear continuously applied or incessantly repeated for an indefinitely long time without continually increasing strain." If the piece is designed with reference to stiffness, the quality for the uncertainty of which provision is to be made is the modulus of elasticity. Experiment seems to show that the modulus of elasticity is not so variable a quantity as is the ultimate strength; in fact, it varies in a very much smaller degree. Thus, if the piece is designed for stiffness, and has, therefore, an excess of strength, the factor of safety that need be used is comparatively small; or, perhaps, some would prefer to say that no factor of safety can be rationally used in designs made for stiffness, and that in such designs the only actual factor of safety is the ratio in which the design for stiffness has made the strength greater than that demanded by a theoretical design for strength, irrespective of stiffness.

In any case it is safe to assume that the uncertainty as to quality applies equally to large and small sections, and, therefore, to guard against the risk of low quality, the areas of large and small sections should be increased in the same ratio. If the risk to be guarded against were that of mere local weakness, this rule would not be mathematically correct. If in a section of 10 square inches, 1 square inch was a spot at which such special local weakness occurred, evidently there would be an overwhelming probability that the same degree of weakness did not occur everywhere else over the same section. It would then be unnecessary to make so great a proportionate allowance for large sections as for small ones. The same reasoning applies to risk of actual flaws, airholes, etc. The application of the factor of safety is rather to guard against general low quality throughout the whole substance of the bar than against local weakness; in any case, if the former be considered the ruling consideration, the result is that the same factor should be applied to all sizes of sections so long as the quality is supposed to be the same. It must not be forgotten, however, that pieces of different sizes of section are usually manufactured either by different methods altogether, or else under very different circumstances, these differences causing great differences in the quality. This applies both to castings, to forgings, and to rolled sections.

The ratio in which sections should be increased on account of uncertainty of quality of material should depend on the care which has been spent in testing specimens of the material to be used. If nothing with regard to this is known by test, if the place of manufacture and the brand be unknown, if, for example, nothing is known but that the material is boiler plate of apparently average quality, then a factor of from two to three seems reasonable if used in conjunction with the reputed average strength as stated in engineering books. If, however, the brand is known, and this brand has been generally and repeatedly tested in a careful manner, and if the results be authentically known, then it appears to the author that from 1½ to 2, according to circumstances, should be an amply sufficient factor of safety.

If, on the other hand, the work being designed is of so much importance that the whole of the material to be used is subjected to systematic test by selecting specimens at random from each lot supplied, it appears unreasonable to suppose that a factor of more than 1½ is necessary; but in these cases a careful analysis of the test results is sure to yield definite information as to the degre of variability of quality in the material, from which the proper factor can be judged with confidence. Unfortunately, these tests usually come too late in the day for the purpose of the design, their primary object being to keep up the quality of the material to the standard for which the design has long since been completed.

The tests referred to in conjunction with the above figures are ,of course, on specimens of material, not upon finished structures. The test of a certain finished boiler or bridge gives information regarding the actual margin of safety in the ordinary working life of the structure, but does not furnish data of use in the designing of the same bridge or boiler, although such results may, of course, be utilized in subsequent designs; but the fact that the structure when finished is to be tested carefully, and perhaps severely, may be allowed to influence the choice of factors of safety used in the design. In such case it seems unnecessary to make provision for the existence of serious flaws in the material, because the test ought to be sufficiently severe to reveal such flaws, and to give opportunity for the removal of the unsound piece and the insertion of a sound one in its stead. It is unnecessary to say that tests are not often carried to such a degree of severity as to make sure of such detection, but they certainly ought to be so if practicable. Commercial considerations sometimes prevent this, and sometimes it is impossible to make so severe a test without danger to life and a large amount of property. It may here be suggested that marine engine crank shafts ought to be subjected to a fairly severe test in the finished condition and before they are sent out to work on long voyages.

Fourth, uncertainty of maximum future load. To allow for this a factor may be applied directly to the loads before the calculation of section is begun. This kind of factor varies much more in different circumstances than do those already mentioned. If the piece is exposed to accidental and incalculable blows, which it is intended that it should be able to withstand, the factor of safety will naturally be taken large. In ordinary circumstances, however, a little careful consideration will suffice to fix the possible maximum load within comparatively narrow limits, and a correspondingly small factor of safety may be applied to this limiting load. The too common method of designing is to direct attention only to the ordinary working load, and then to multiply by a factor of safety chosen pretty much at random. The right process is evidently to consider as accurately as may be all the future possibilities as regards load during the whole life of the structure or machine. If this be done, it will be found that in the majority of cases there can be no reason for applying a factor of safety of more than 1½ to such possible maximum load; in many cases it need not be more than 1 1-5 to 1¼; and it is seldom that there is any necessity to take more than 2 as the multiplier.

The load is often made up of different parts, one of which can be calculated beforehand with a moderate degree of certainty and exactitude, while about the other there is considerable uncertainty. Such, for instance, is the case of a member of a bridge, the force along which, due to the dead load, can be reckoned to a close degree of approximation, while that due to the live load is much more uncertain in amount, especially if this last be taken to include the effect of stress of weather. In such circumstances the factor of safety is to be applied only to that portion of the load which is uncertain. This is in nearly all cases the variable part of the load. As repetition of such heavy load as the structure will easily and safely bear when applied only once has long been believed to create risk or certainty of failure, it is necessary to consider more in detail the result of applying factors of safety to variable loads.

In order to do so it is convenient to express by some exact law the influence which is commonly referred to as the "fatigue of materials." This influence is practically recognized when one endeavors to break a stick or rod of metal by bending it backward and forward, but it was first investigated by accurate experimental methods by Wöhler.

When the stress in a piece of material varies and the variation is repeated an indefinitely large number of times this may be called a "stress oscillation." The effect of the rapidity of the oscillation has not yet been accurately investigated, and cannot yet be taken into account in calculation, although, no doubt, it has a very material influence. For instance, the strengths of the reciprocating parts of an engine are very possibly considerably influenced by the speed of the engine, independently of the stresses due to acceleration of momentum.

For a given lower limit of stress in a stress oscillation there is a corresponding upper stress limit, which, although it will not immediately break the material, will do so if the stress oscillation be kept up for a long time. Such an oscillation may be called a "breaking stress oscillation." If in any actual stress oscillation the upper stress limit is less than the upper stress limit of the breaking stress oscillation with the same lower stress limit, breakage will not occur although the oscillation be kept up indefinitely. The greater the range between upper and lower limits in the breaking oscillation the less is the upper limit.—The Mechanical Engineer.

ENAMELING.—II.

FROM the preceding article in our impression for August 23, it will be understood that the enamel constituents are divided into four distinct groups: I. Fundamental media. II. Flux media. III. Decolorant media. IV. Coloring media. We have briefly considered the three first named, and we will now proceed to No. IV. The coloring material used is in every case a metallic oxide, so that, so far as this goes, the coloring of an enamel frit is easy enough. Great care is, however, necessary, and at times many difficulties present themselves, which can only be overcome by experience. To have a complete and thorough knowledge of the coloring process the operator should have gone through a course of study in chromatics. This, however, is what English operators have not done, but which German manufacturers make compulsory for some of their staff, and with most satisfactory results. In addition to chromatics the operators should have a considerable knowledge of chemistry. In this, again, the German operator excels his British rival. This knowledge of chemistry is of the utmost value throughout the whole manufacturing course of enamels, and it is quite safe to say that a good chemist who is also a practical manufacturer will do much better for his firm than a highly-trained operative staff under a head whose knowledge of chemistry is very limited. Coloring oxides are very frequently adulterated, and certain kinds of the adulterants are injurious to the frit and to the finish of the color.

When the color to be used has been decided upon, the other points requiring consideration are: (1) The object for which the article is to be used; (2) the price to be obtained for it. Artistic coloring runs into considerable sums of money at times, as a high surface finish on an art work surface requires the best materials, the most careful manipulation, and a considerable expenditure of time and labor. Some colored frits are chiefly made to attract the eye rather than to stand long wear, and this is especially the case in the manufacture of hollow-ware. It is well known that the natives of India, Africa and other parts of the globe have original and peculiar ideas as to what constitutes art. In India, for example, the native men and women who can afford it revel in a dress of the most varied and gaudy colors, regardless of their sympathetic affinity with one another. The more striking and divergent the colors are the more they are appreciated, and this characteristic applies to almost everything else.

In this the German comes to the front again. In shipping to foreign countries he finds out the most popular colors in vogue. To him it matters not how hideous they may be. His aim is to get money for his goods, and combinations of the most startling characters are turned out in the cheapest form possible. The Englishman seldom seems to grasp the trade necessity of making every effort to fall to the level of the native in matters of this kind. What he thinks he ought to do is to educate him, and bring his ideas to the level of appreciating Western views of art colors, etc., but while he is thus engaged his continental competitor is reaping a harvest of rupees which might otherwise have been his.

In Germany coloring minerals are very generally prepared in the laboratory connected with the enameling factory, while in England this system is unknown. The advantage of this arrangement is that the coloring oxide is prepared in a sufficient condition of purity for the object in view, whereas the English manufacturer has to depend upon the more or less definite assurances of quality given by outside suppliers.

The following is a list of the colors directly available for enameling. The depth of tint can be varied as required by varying the quantity of media used, and variety may also be obtained in some cases by the combination of two or three colors. The following commercial colors fairly pure can be obtained from reliable manufacturers, but a brief description of their composition will be of use: Blue of sorts, violet, green of sorts, yellow of sorts, orange, red of sorts, brown of sorts, black.

Blue.—The most popular color in enameling is blue, and no other color is capable of yielding such a range of beautiful variations. Everyone is familiar with the rich dark tints often to be found in cheap enameled articles, and in the finer enamels it has no equal. Cobalt is now generally in use for imparting this color, and the best form in which it may be used is silicate of cobalt or smalt. Silicated protoxide of cobalt gives much finer results, but the cost of the pure oxide is much greater.

Violet.—Peroxide of manganese is the only oxide which will yield this color, and only after it has been made chemically pure. For ordinary purposes finely powdered manganese used in small quantities will give the required violet tint. By the use of this oxide any shade of violet, from the very lightest to an almost perfect black, can be obtained.

Green.—Every one knows that blue and yellow in certain proportions will yield a green color. The same rule applies in enamel mixings, but is not generally brought in practice. Green so obtained requires more trouble and offers less certainty of satisfaction than direct coloring, hence the latter is now generally in favor. Oxide of copper yields an emerald green, but the color can be modified in any way by the judicious addition of oxide of iron.

Yellow.—The ranges of yellow are considerable, but very few tints can be described as artistic. The most popular is known as Naples yellow, and the recipes for its manufacture are numerous, and will be given at a later stage.

Orange.—This color is, of course, a combination of yellow and red, its depth depending upon the relative percentage of its two constituents. A red iron and an antimony preparation are employed. If the former exceed the latter an orange red will result, and if the latter predominates an orange yellow will be obtained.

Red.—Sulphate of iron and alumina produce the commercial red. Its preparation requires great care, but with experience a first-class color can be obtained. Oxide of gold can be used, but it is too expensive.

Brown.—As is generally known this color is a combination of black and purple. Some brown colors are most objectionable, but a really good tint can be obtained by mixing a certain proportion of clay with oxide of iron.

Black.—There is no distinct preparation of this type, but the color is arrived at by the addition to the frit of oxides of deep coloring power, viz., oxide of iron, oxide of cobalt, or peroxide of manganese. The blacks obtained from these can easily be identified by an expert. A pure velvet black can be obtained by mixing these oxides together and fusing with the enamel frit.

EXPERIMENTAL WORK.

Experimental work will save many pounds to a manufacturer, and, in fact, it is only by an organized system of experiments that the best results can be arrived at. Everyone connected with the trade knows how serious the losses are from spoiled mixings, not only in colored enamels, but also in the white and gray mixings. The cost of the materials, wages, coal, etc., amounts to a very large item; but where each separate batch is first tested in a small experimental way these losses are almost wholly avoided. German manufacturers never trust to chance; the experimental laboratories in connection with their manufactories are fully equipped, and considered of the utmost importance, whereas in England the experimental tests are neglected as much as possible. It frequently happens in practice that a mixing of certain articles in certain proportions will give different results at different times, although the system of manufacture is unaltered. This may be due to the quality of the ingredients varying in different consignments, and it is obvious that if uniform enameling results are to be obtained with as little waste as possible, it can only be by experiments.

COMPARISON OF HOLLOW-WARE AND SIGN TABLET ENAMELING.*

The enameling for sign tablets is much the same as for hollow-ware; the mixings are practically alike, but, as a general rule, the mixing is applied in a much more liquid form on the latter. It is easy to understand that hollow-ware in every-day use receives rougher usage than tablets. By handling it is submitted to compression, extension, and more or less violence due to falls, knocks, etc., and unless, therefore, the enamel coating follows the changes of the metal due to these causes, the connection between the two will become loosened and chipping will take place.

The enamel, therefore, though much alike for both purposes, should be so prepared for hollow-ware that it will be capable of withstanding the changes to which we have referred. In all cases it must be remembered that the thinner the coat of the enamel the better it will be distributed over the iron, and the greater will be its adherence to the iron. Any article heavily enameled is always liable to chipping, especially if submitted to the slightest bending action, and therefore any excess of material added to a plate means that it will always be readily liable to separate from the plate. In hollow-ware enameling the preparation of each frit generally receives somewhat more attention than for plate enameling. The grinding is more effectively carried out, in order to remove almost every possibility of roughness on any part of the surface, especially the inside surface.

The iron used in tablet and hollow-ware manufacture is rolled sheet iron. It is supplied in a variety of qualities, from the ordinary Lowmoor and Swedish irons to specially prepared charcoal irons. For hollow-ware the latter are essential. The difference between the two is in the preparation, whereby the charcoal iron is rendered purer than ordinary plate iron, more ductile, and therefore capable of being driven out to various forms and depths by stamping presses. The surface of the charcoal iron is not so liable to become oxidized, and therefore can be more readily made chemically clean for the reception of the enamels. Some manufacturers use charcoal plates for tablet work, but these are expensive; the ordinary plates, carefully pickled and cleaned, adapt themselves to the work satisfactorily.

The sheet irons generally used for the enameling purposes referred to vary in gage (I. S. W. G.) from 25 to 19. The finer the iron is the greater must be the care used in coating it with enamel. Thin iron will rapidly become hot or cool, the temperatures changing much more quickly than that of the mixing. Unless care, therefore, is used, the result of fusing will be that the enamel mass will not have become thoroughly liquid, and its adherence to the iron will be imperfect.

If, however, the temperature is gradually raised to the maximum, and sympathetic combination takes place, the dangers of rapid cooling are avoided. Again, the iron, in losing its temperature more rapidly than the enamel, will contract, thus loosening its contact with the glaze, and the latter will either then, or after a short period of usage, chip off. We then arrive at the following hard-and-fast rules: (1) In all classes of enameling, but particularly where thin iron sheets are used, the temperature of the plate and its covering must be raised very gradually and very uniformly. (2) In all cases a plate which has had a glaze fused on its surface must be cooled very gradually and very uniformly. The importance of these rules cannot be overestimated, and will, therefore, be referred to in a more practical way in a later article.

In enameling factories no causes are more prolific in the production of wasters than these, and in many cases the defects produced are erroneously attributed to something else. Cast iron is much easier to enamel than wrought iron. This is due to the granular character of its composition. It retains the enamels in its small microscopic recesses, and greater uniformity can be arrived at with greater ease. Cast-iron enameled sign tablets and hollow-ware were at one time made, but their great weight made it impossible for them ever to come into general use.

Wrought-iron plates, if examined microscopically, will show that they are of a fibrous structure, the fibers running in the direction in which they have been rolled. The enamels, therefore, will be more liable to flow longitudinally than transversely, and this tendency will be more accentuated at some places than at others. This, however, is prevented by giving the iron sheets what might be described as a cast-iron finish. The sheets to be enameled should be thoroughly scoured in all directions by quartz or flint sand, no part of the surface being neglected. This thorough scrubbing will roughen the surface sufficiently to make it uniformly retentive of enamel mixture, and in no cases should it be omitted or carelessly carried out.

Cast-iron pipes for many purposes are now enameled, and even enameled locomotive boiler-tubes have been heard of. When properly covered with the glaze corrosion is impossible. The importance of this result will be at once fully estimated, but it is to be regretted that English manufacturers are again behind their continental neighbors in the uses of the enameled tubes and pipes. The process necessary is not a difficult one, and it has also the recommendation of inexpensiveness, but in every part of the operations great care is necessary. As in the case of sheet iron, cleaning and pickling are essential, and both operations must be as thorough as possible. The whole of the surface must be freed from any trace of corrosion, after which a gum coating may be applied. On the surface to be glazed the powder is uniformly distributed, and this is best done by the use of cylindrical brushes.

The furnaces are long, but narrow, as the attendant workman has to turn the tubes from time to time, and he is therefore only capable of attending to from six to twelve. The tubes are laid side by side, and rest on "petits" suitably shaped for the purpose. The turning is done by means of strong pincers, and on the uniform change in position of the pipes the uniformity of the enamel glaze very greatly depends. The furnace is necessarily heated to a very high temperature, and the uniform distribution of the heat throughout the pipes can only be obtained by a competent workman in charge. Most of the defects generally to be found in cast-iron pipe enameling can be traced to bad firing, and carelessness at this part of the process should never be tolerated. Two coatings are applied, viz.: (*a*) The foundation coating, and (*b*) the upper coating, and these consist of: (*a*) Soda, borax, quartz; (*b*) feldspar, quartz, borax, oxide of tin, fluorspar, soda, and saltpeter. Other firms use different mixings, but those just given are very satisfactory when properly applied.

Water pipes, drain pipes, boiler pipes, etc., can all be made more useful and lasting by being protected with an enameled surface. Sanitary operations are more perfectly effected, and in water conduction the water is protected from contamination.

Copper Enameling.—On a clean copper surface the enameling process is easy. The foundation glaze is not essential, and when required the most beautiful results of blended colors can be obtained by very little additional experience to ordinary enameling.

Enameled copper-ware has now come greatly into favor for household ornaments. Japan has for many years been turning out enormous quantities of vases, plaques, bowls and other ornaments most beautifully enameled in a variety of colors of the most delicate tints, and attempts have been made in Europe, but without success, to introduce a competitive industry. For this class of work the operator must have served a long apprenticeship, have a high conception of what art is, be possessed of a standard of patience of the most perfect character, and be content to receive comparatively small return for the work. The system adopted in this class of work is easily explained and understood, but the manufacture itself is one which requires the patience and application of the Oriental, and with the Oriental it will remain.

When the vase or other article has been hammered out to the required shape in copper, it is passed on to another class of artisans, who prepare it for the hands of the enameler. The design or designs are sketched carefully out and with most wonderful precision. The working appliances consist only of a pointed tool, two or three small punches of varying sizes, and a hammer. With this small equipment the operator sets to work. The spaces between each dividing line are gradually lowered by hammering, and when this has been uniformly completed, each little recess is ready to receive its allotment of enamel. More accurate work even than this can be obtained by the introduction of flat wire. This wire is soldered or fixed on the vase, and forms the outline for the entire design. It may be of brass, copper, or gold, but is fixed and built round every item of the whole design with the most laborious care. It stands above the surface of the design on the copper articles, but the little recesses formed by it are then gradually filled up by enamel in successive fusings. The whole surface of the article is now ground perfectly smooth and polished until its luster is raised to the highest point possible, and when this stage has been reached the article is ready for the market.

To give an idea of what Europe would have to contend against in attempting to enter into competition with Japan in this industry, the following trustworthy figures relating to a pair of vases, with no fittings or ornamentation except that of color, will be of interest: Height of vase, 12 inches; value of copper, 3s. 6d.; value of enamels used, 2s. 6d.; cost in working, 6d.—excepting wages; incidental, 6d.; actual cost of material, 7s.; actual time taken to finish the vases—calculated as for one man—thirteen days; selling price in Japan, 12s. 6d. Enamels used for this and other kindred purposes must have a low fusing point. Practically they must be lead enamels, but of a fineness and purity much superior to those for ironware. Here is a selection: White—(*a*) crystal glass, antimoniate of sodium and saltpeter; (*b*) oxide of tin, fine quartz, and salt. If colored enamels are to be used the coloring media requires the greatest care, as the artistic effect depends almost wholly on the shades of color obtained. At a later stage recipes for various colors will be given. Ordinary copper and fine copper enameling are two different processes, as can be understood. A good ordinary copper enamel consists of gypsum, feldspar, and borax, which is applied in a similar manner to that of iron.—The Engineer.

CONTEMPORARY ELECTRICAL SCIENCE.*

CURVES TRACED BY POINT DISCHARGES.—De Heen described some time ago a novel experiment, in which a plate of resin was charged and then held over a number of Bunsen flames. Each flame discharged a portion of the plate, and the various portions were sharply marked off from each other along lines which could be made visible by dusting with sulphur, lycopodium, and carmine. R. H. Weber has repeated the experiment, not with flames, but with point electrodes, and found that exactly the same phenomena are produced by them. The tracings show lines resembling honeycombs. The plates remained charged along these lines, and the author attempts to give an explanation of this fact. A single point opposite a metallic surface produces a discharge which proceeds along a paraboloidal path, and the paraboloid can be traced by laying a piece of tissue paper over the metal and observing the luminous effect. It can also be traced photographically by introducing a piece of bromide paper between the plate and the tissue paper. Two such paraboloids side by side behave like elastic bodies, and flatten each other where they touch. That the discharge consists of material particles may be proved by directing an air blast at right angles to it, when it is found that the straight lines described bulge out in the direction of the blast.—R. H. Weber, Ann. der Physik, No. 9, 1901.

CATHODE RAYS.—W. Seitz has repeated and extended a number of experiments in connection with the reflection and absorption of cathode rays. These rays are, as we know, diffused by metallic surfaces they impinge upon. At normal incidence the intensity of the reflected rays decreases approximately as the cosine of the angle of reflection. At slanting incidence different metals show a different behavior. In aluminium, zinc, iron, and copper the maximum intensity of the reflected rays is displaced toward the direction of metallic reflection, while platinum, gold, and silver reflect most strongly in a direction comprised between the incident ray and the normal to the surface. In the first class of metals the reflection distinctly increases with the angle of incidence, while it decreases somewhat in the second class. At normal incidence the reflective power increases with the atomic weight, but zinc does not fall in well with the series. An important result of the author's work is that the coefficient of absorption increases with the thickness of the absorbing film, and Lenard's law, according to which films possess equal absorbing power if they have equal masses per unit of area is, therefore, only true as a first approximation. That this difference is not of a frictional nature is proved by the fact that no difference in the electric or magnetic deflection is produced by passage through an aluminium window.—W. Seitz, Ann der Physik, No. 9, 1901.

PHOTO-ELECTRIC EFFECTS.—The lowering of the spark potential by ultra-violet light discovered by Hertz, and the dissipation of an electric charge under the same influence discovered by Hallwachs show a marked difference in the extent to which they are influenced by the material of the electrodes. Iron, which is particularly sensitive in the Hertz effect, behaves with marked indifference in the phenomenon described by Hallwachs and studied in detail by Elster and Geitel. The greater the anodic character of the metal, the greater its sensitiveness; and the maximum sensitiveness lies at greater wave-lengths in the same proportion. Almost all heavy metals only respond to ultra-

*Compiled by E. E. Fournier d'Albe in The Electrician.

violet light of great refrangibility. H. Kreusler has sought to reconcile these differences by bringing the potential of the electrodes close up to the actual sparking potential, when the reaction becomes exceedingly sensitive. If $V_o = 4{,}060$ volts is the spark potential and V the cathode potential in the photo-electric apparatus, then for $V_o - V = 560$ the sensitiveness of copper is nearly 30 times that of iron. But when $V_o - V = 30$, copper is only three times as sensitive as iron. Under ordinary circumstances copper is about 37 per cent more sensitive than zinc. But when a copper and a zinc ball are taken and well polished, the zinc turns out to be some 10 per cent more sensitive than the copper.—H. Kreusler, Ann. der Physik, No. 10, 1901.

THE BERLIN-ZOSSEN HIGH-SPEED ELECTRIC RAILWAY.

BEFORE the International Engineering Congress, at Glasgow, Scotland, Mr. A. Lasche, of Berlin, read a paper on the proposed plans for carrying out experiments in high-speed electric traction on the military railway between Berlin and Zossen. Through the courtesy of the Allgemeine Elektricitaets-Gesellschaft, of Berlin, we have obtained a copy of this paper, from which we translate the more important portions for the benefit of our readers.

The German Association for the Study of Electrical High-Speed Railways has been instituted for the purpose of gathering experimental data on the electrical operation of long-distance railways, and on the construction of cars, the consumption of power, and the wear and tear of the permanent way as well as on the limits within which railways can be economically operated by electricity. The theoretical study of the question and the resulting experiments have so far been only of a general character and have had no reference to the planning of any special track. The first trials will soon be commenced on the military railway between Berlin and Zossen, which the Imperial Military Board of Administration have placed at the disposal of the association.

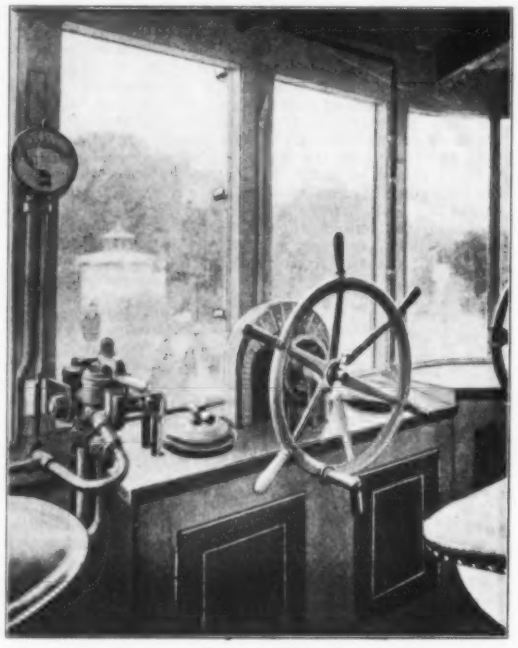
As the maximum for the present construction of car, a speed of 200 kilometers (124 miles) per hour has been assumed; but this does not imply either that the main object of the experimental line will be the attainment of this speed, or, that there may not be a possibility of exceeding that speed. The chief purpose of the trial is to establish a sound basis for the construction and operation of lines at the usual or at higher speeds. Naturally the object of the present experiments, and of those to be conducted within the next few years, will be to compare the economy of the electrical system with those in which steam is the motive power employed, and to ascertain the total cost of each system when running at different speeds, and especially at high speeds. The ability to run separate motor cars in rapid succession is one of the greatest advantages of electrical traction; such a service of motor cars has been proposed for use on suburban and long-distance lines. With this end in view the experimental cars of the association have been built in the form of passenger cars instead of locomotives. Moreover, the existing permanent way, bridges, etc., may be retained, because, in place of heavier locomotives and longer trains, light and separately driven motor-cars will be used.

It is hoped that the experiments will furnish material for the calculation of the operating expenses of electric main lines, and also of the efficiency of motors for the various speeds and the increasing influence of air resistance, as well as the determination of the size of the power stations. The lower limit of speed at which electrical may be more economical than steam traction is about as little known as the higher limit. It is only known that with steam locomotives the consumption, both of steam and of coal, is very greatly increased with increasing speed. But by centralizing the generation of power the conditions will, of course, be entirely different. This centralization—and consequently the attainment of a practically uniform load—is now possible for very long distances. Three-phase alternating current can be generated at a pressure of 40,000 or 50,000 volts, so that electrical energy can now be transmitted for very great distances without serious loss. And all the railway lines over a large area can be fed with a current from a favorably situated central station.

NATURE OF CURRENT USED.

As the problem to be solved is that of long-distance transmission the current to be adopted should be the three-phase alternating current of high tension. For the road, a current of only 10,000 to 12,000 volts is necessary, which current is supplied by the Oberspree central station of the Berliner Elektricitaetswerke, the distance from the central station to the nearest point on the line conductor being about 15 kilometers (9.3 miles). At present the current supplied has a voltage of 10,000 to 12,000. The transformers are carried by the car itself, a low voltage (435) being used for the motors. So far as the future developments are concerned it is still questionable whether it is advisable to mount the heavy transformers on the car or whether it is not better to reduce the high pressure—50,000 volts—by transformers alongside the track to a medium pressure of about 3,000 volts and to wind the motors for this latter voltage.

It is not practicable to convert three-phase into continuous current for long-distance railways, because rotating machinery must be employed which necessitates no little attendance. On the other hand, transformers for varying the potential of three-phase current have no moving parts. Furthermore, direct current requires but a low voltage, and consequently the distances between transforming stations cannot be great. It might, however, be necessary to use direct current for long-distance cars while traversing a large city, the three overhead wires of the triple-phase system being inconvenient for crossings; a slow-speed locomotive could then be coupled temporarily in front of the car.



THE DRIVER'S COMPARTMENT.

The problem which confronted the Allgemeine Elektricitaets-Gesellschaft was this: To construct a motor car to run at a speed of 200 kilometers per hour in order to accommodate 50 passengers, the car to run on two trucks with three axles each and the motors to be adapted for a total output of 1,100 normal and 3,000 horse power, the electrical current provided to be three-phase at 12,000 volts and at a frequency of 50 complete cycles, the weight of the cars to be as small as possible, and on no account to exceed 8 tons per wheel, and the shape to be such that the car would be within the standard gage of the lines of the governmental railways.

PRELIMINARY EXPERIMENTS.

(1) *Weight of the Electrical Equipment.*—The entire apparatus, cable and safety devices are arranged in a middle compartment, which, together with the transformers beneath it, is separated from the passenger compartments by double-wall air-shafts of iron. The driver stands at the front of the car, separated from the passengers, in a compartment in which there are no connections at high electrical pressure.

In making the calculations for the transformers and determining the cross-sections necessary for the iron, the question of the heating and cooling of the iron and of the upper coils is of the greatest importance. To cool the transformers by air taken from below the car was impossible, by reason of the dust raised when traveling at high speed. Two air-shafts were led from the roof to the transformers in such a manner that fresh air was received through the front shaft and heated air discharged through the rear shaft. Moisture was withdrawn from the air during rainy weather. The weight for the transformers was finally determined at 14.3 pounds per kilowatt and for the motors 28.7 pounds per horse power for the normal output and 9.5 pounds per horse power of the maximum output.

(2) *The Mounting of the Motors.*—It was a matter of considerable difficulty to decide whether the motors should be spring-mounted against the axle or rigidly secured to the axle. The spring coupling was finally decided upon. One of the chief difficulties in designing the coupling and bearings was the considerable deflection of the springs when the motor was attached to the car or truck. Arrangements for supporting the motor by a number of small springs did not seem to afford sufficient security, although the motion of a few millimeters should be sufficient. The motor was no longer connected with the truck-frame, but supported by strong springs bearing against the axle-box and having a deflection of but a few millimeters. By means of an adjustable curved block for the first one or two millimeters this spring bends very readily and then grows stiffer to a maximum of 8 to 10 millimeters. The motor is finally screwed to a frame of sheet iron with channel iron bars. This frame is supported on both sides of the car on plate springs, resembling the usual car springs, the buckle being mounted by means of the buckle of the axle springs at the axle box. The motor is prevented from moving laterally by suitable abutments, which bear against the slides. Means were also provided to prevent rotation of the stator in either direction. Alterations which were made during the manufacture will be referred to later. With this simplified construction it was possible to make the coupling shown. In the form adopted this frictional resistance is diminished to less than 1 per cent, or, in other words, it is practically obviated. The reduction in the reflection of the spring allows the diameter of the hollow shaft to be diminished, and so the construction of the bearings is simplified and their lubrication is facilitated.

(3) *Starting Devices.*—A three-phase current motor of 200 to 400 horse power is coupled direct to a very heavy fly-wheel. In order to bring this up to full speed in 15 seconds, a torque corresponding to an output of 400 horse power must be attained. A small centrifugal pump driven by an electro-motor raises the liquid from a reservoir in the basement, and continually delivers it into the tank in which the electrodes—i. e., the terminal or end plates of the opened armature circuits—are located. The pump operates continuously; hence a constant renewal and mixing of the liquid takes place, and the electrodes are thus suspended, not in stationary, but in moving water.

The essential difference between the new starting device and those previously used consists in the maintenance of the liquid in constant motion—a fact which alone suffices to ensure its use. The heated liquid does not remain at the point where heat is being generated, but is constantly circulated and mixed afresh. It is easy to calculate what amount of heat is communicated to the liquid by the resistance at any given load, or for a given decrease in the normal speed; and the use of water in motion renders it easy to conduct away this heat. The cooling surface necessary to effect this may be readily calculated; and in the present construction of the high-speed car systems of serpentine copper tubes of small diameter are provided, through which the heated water has to pass after leaving the electrode vessel and before it is used afresh. Consequently the new liquid starting device enables any suitable large resistance to be brought permanently into the circuit, and the motor can be run continuously at any slow speed that may be required.

Owing to the great simplicity of the apparatus, it can be readily operated from a distance, as the power required is excessively small. Consequently the provision of compressed air or electricity in the car as a means of operating the reversing mechanism is rendered unnecessary; all that has to be done is to provide a connecting shaft operated by a hand wheel from each driver's platform. When using the new system of liquid starting device the metallic arrangement is no longer needed, and the several hundred contacts and cables are dispensed with. In regard to maintenance no fear need be entertained, since, of course, the maintenance of plates not liable to become rusty, immersed in a soda solution, cannot be compared with that of many and large controller cylinders, contacts, contact brushes, cable connections and pieces of resistance material.

(4) *Brakes.*—The system of electrical braking with the aid of the motors was also tested by means of the same experimental arrangement that had been constructed for testing the starting apparatus. The car is equipped with a Westinghouse compressed air brake, divided into two parts for each of the two trucks. The compressed air cylinders are operated from the front driver's platform. The brake pressure is assumed to be very high—170 per cent—because the coefficient of friction between the brake block and wheel at the high speed employed—above 50 meters per second—is materially different to that at the usual lower speeds. In consequence of investigations that have been made, an appliance has now been devised for decreasing the brake pressure at a gradual slow speed. Notwithstanding the fact that to a certain extent the brake arrangement of the one forms the reverse for the other truck, it was not considered admissible to dispense with a second brake. This additional braking action was imparted by the motors themselves, and not by special rail brakes or similar less approved apparatus.

The braking or retarding action can be effected by means of an electro-motor in one of two ways—either by eddy currents, namely, by energizing the field of either the motor with continuous current and short-circuiting the

THE CAR FOR THE BERLIN-ZOSSEN ROAD

armature, or by reversing the direction of the rotation field. Both kinds of brakes are used on the high-speed car. After the armature circuit is opened by opening the outlet valve of the liquid starting device, the field is cut out and switched on to a storage battery placed within the car, or reversed to oppose the current, with two of the three phases reversed, the series arrangement of the phases being changed from 1, 2, 3 to 1, 3, 2 and 3, 2, 1, respectively. After the switching has been effected in either way, the armature circuit is gradually closed again, i. e., the inflowing liquid makes contact under very great resistance, and the level of the liquid is then raised or lowered, according to the amount of braking action that may be desired.

Braking by means of counter current alone did not appear to be sufficient, because the current was apt to fail for some reason or other, as, for instance, by the melting of a safety fuse at the very moment when the brake was applied. The use of a counter current has a further disadvantage. In consequence of the electrical construction of the motor and the potential of about 430 volts selected for the field, the armature has an electric pressure of about 325 volts on open circuit. After the reversal of the field the tension in the armature increases at full speed to almost double the amount, viz.: to about 650 volts. Although the liquid starting device is intended for this voltage and the motor armature is also fully capable of sustaining it—it was tested at 4,000 volts—yet it appeared unwise to allow the safety of the braking action to be dependent on an unusually high voltage just at the time when the brake is brought into action, and when there is a possibility of danger. These were the reasons which led to the provision of an eddy-current braking system, and for this purpose there were two entirely separate storage batteries, corresponding to the two separate air receptacles for the Westinghouse brake. It is here assumed that motor braking must be made use of at high speeds, and that the air brake is only applied at the end of the run. For shunting service, a hand brake is provided to act on the front truck.

(5) *Trolley-Bows.*—The current is led to the three vertically superposed wires, from which it is taken into the car through bow-shaped collectors. By this system of taking the current, in which a deflection of the trolley wire between the connecting points does not affect the bow, the jumping of the latter is more readily avoided than if it made contact from below. Notwithstanding this fact, the question of the trolley-bows had to be very carefully studied, and although the requirements for a speed of 50 to 60 meters per second could only be very incompletely complied with, an experimental arrangement was nevertheless made. Three arms are arranged on the roof at each end of the car, one for each of the three phases. The distance between the arms is determined by the space required by the bows when being turned round their vertical axis. These distances are, however, made as small as possible, and the arms are located close to the pivots of the trucks so that there may be no material change of the distance of the wires in passing round curves. Two systems of bows were considered necessary, so that, in the event of one bow failing to act, the current would be taken from the other and no sparking would occur. Further steps were then taken in the direction of increasing the number of contact surfaces and of reducing as far as possible the mass of the metal which has to slide along the wires. A number of aluminium bows were connected to the trolley pole by plate springs of different lengths. The object of this elastic arrangement was to ensure a good permanent bearing on the wire, but in the event of one bow failing to make contact the others must be sufficient to carry the current. In the event of greater deviations of the conducting wire taking place, the main spring arrangement of the whole arm will begin to act. Further particulars are contained in that part of the description which treats of the manner of taking and supplying the current.

THE CAR AND ITS ELECTRICAL EQUIPMENT.

The Body of the Car.—The car, specially constructed to suit the electrical equipment, was built by the firm of Van der Zypen & Charlier, of Cologne-Deutz, to accommodate 50 passengers. The over-all dimensions of the body of the car, including the apparatus compartment and driver's cabs, are 21 meters (69 feet), and the distance between the buffer plates 23.10 meters (75½ feet). The full width of the car is 2,600 millimeters (8 feet 6 inches). The body of the car is within the standard profile throughout its length, but especially in the middle part, with its wide air ports there is not much margin to spare in this respect. The windows of the car are closed, ventilation taking place through the side window of the lofty skylight. On either side, at each end of the car, doors are provided to allow of the entrance and exit of the passengers. The driving platform is separated from the passengers' compartment by a wide partition extending from the bottom to the top of the car and serving as a back support for the driver. At the sides of this partition are grated doors which, during stoppages at stations, are arranged in such a manner that the compartment remains shut off from the passengers, without interfering with the free access of the latter to the interior of the car. During the run these doors are so adjusted that they prevent the passengers both from reaching the exit and from disturbing the driver. The car is divided into two compartments by that containing the apparatus. The passengers can, however, freely pass from one compartment to the other, even when the car is in motion, as the apparatus compartment is protected in the same way as the driver's platform. Any portion that is liable to be touched from the gangway either does not carry current or is suitably insulated.

As will be seen in the section devoted to the arrangement of the cables, neither the passenger compartments nor the driver's platforms are under current. The trolley-bows on the roof of the car are fitted with two insulators connected in series, each of which is tested for a potential of 20,000 volts. The high-tension current passes from the bows to the transformers through high voltage cables, which, in spite of their having been tested for 20,000 volts, are laid in high-tension insulators. Between the so-called apparatus compartment and the passenger compartments, and also between the latter and the transformers which are suspended below them, there are air shafts which form a double-walled inclosure. The storage batteries alongside the transformers are likewise separated off by double sheet metal walls.

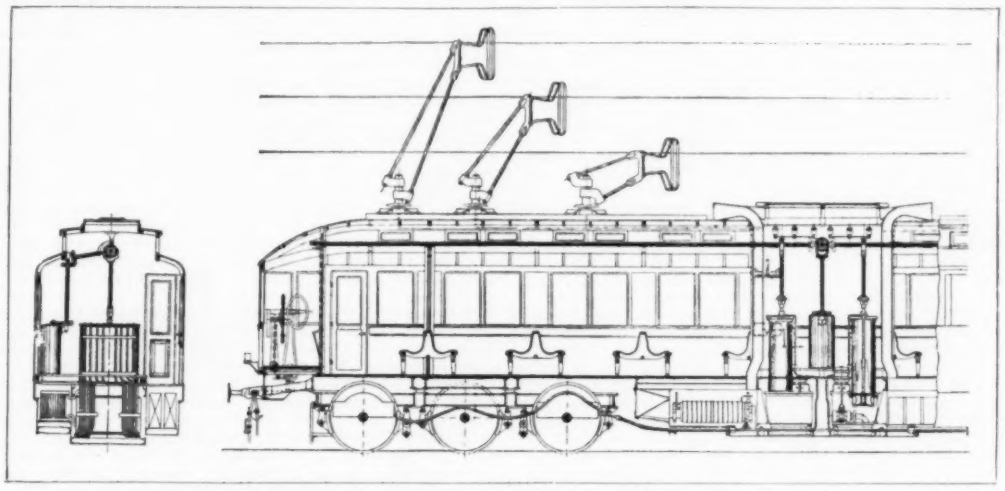
Running Gear.—The two trucks which carry the body of the car are 13.3 meters (43 feet 7 inches) apart. The diameters of the wheels are assumed to be 1,250 millimeters (49.2 inches), which allows for a sufficient turning movement of the trucks below the car without necessitating any alteration in the floor level at any part of the car. Each of the trucks has three axles, the two outer axles carrying the motors, while the middle axle allows the necessary space for the pivot and for the air cylinders of the Westinghouse brake. The distance between the wheels measures $2 \times 1{,}900$ millimeters (12 feet 6 inches). The load for each axle is less than the maximum allowable, and amounted to a little over 14 tons. No springs bearing against the body of the car are provided. The trucks themselves are supported on the axles by two sets of springs; and each axle-box carries a strong plate spring, to the heads of which are attached supporting springs carrying the frame.

The Motors.—Each of the eight motors is adapted for a normal output of 250 horse power, and for a maximum output of 750 horse power. The speed of the motor is about 960 revolutions per minute, which corresponds to a car speed of 225 kilometers (140 miles) per hour. The tension of 12,000 volts, at which the current is supplied from the overhead wire, is reduced in the transformers to 435 volts. This voltage was adopted so as to permit of the motors being constructed with bifurcated winding. Although the motor, as above stated, is not subjected to severe mechanical shocks, it was nevertheless deemed advisable, to insure permanent safety in working, to give only one single bar in the separate grooves instead of a number of wires insulated from each other by cotton covering. The insulation of the bars from the iron is effected by closed micanite tubing. The armature winding—at the tension of the regulating apparatus—like the field winding—transformer low-tension—is also bifurcated. For sake of convenience in the starting apparatus and the arrangements of the cable, the armature was wound for only two phases, and not, as is usual, for three phases. The stator, by means of two bearings, carries the hollow shaft on which the rotor is built up. One of these bearings carries on its upper half the brush gear for making contact with the slip rings, and the connections for the cables of the armature circuit which lead to the regulating apparatus. The cables of the casing circuit are passed through the other bearing. The bottom halves of the bearings can be easily removed to allow of the removal of the brasses and to give free access to the brush gear.

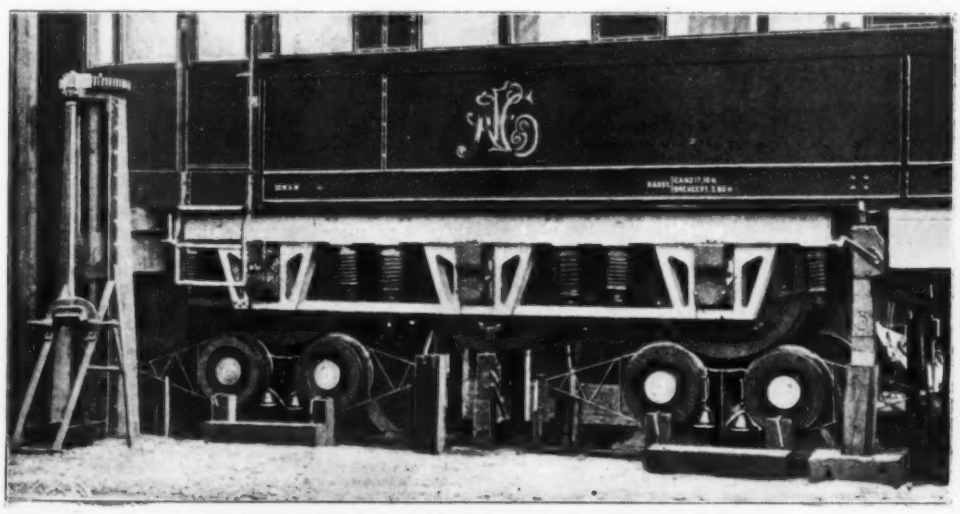
The spring couplings are fixed to the hollow shaft at both ends. The object of this coupling was to transmit the power developed by the motor—750 horse power maximum at 960 revolutions—from the hollow shaft to the wheels, thereby allowing the wheels a displacement of 10 millimeters relatively to the coupling arms. Hence the arms had to be elastic, and, moreover, the head must be able to slide against the guides mounted on the wheel. The construction of the whole required a division of the coupling into three parts, corresponding to the three double arms that were adopted. The springs are secured in the annular pieces by wedges in such a manner that the tension of the wedges is further increased by the centrifugal force applied. Furthermore, the plates are extended laterally within the hub, and are thus prevented from flying out. The hub portions are of forged steel, of ample cross-section. The power is transmitted by means of keys from the hollow shaft to the three-part hub of the coupling.

Transformers.—The three cores of the transformers are arranged side by side in accordance with the patents of the A. E. G. The axles of the cores run longitudinally in the car. The current transformation being from 12,000 volts to 435 volts, a massive copper spiral is used for the low-voltage winding, and the outer or high-voltage winding is separated from it by a micanite cylinder. A strong current of air passes through a longitudinal channel provided in each of the iron cores, and also through the space between the square cores and the round inner coil. As already mentioned, the air for this purpose is received through large air holes in the roof, and is delivered through air ducts to the transformers. A protecting angle iron is provided on the roof for the removal of rain water, and before the air enters the shaft and the channels it passes several times through wire netting with wide meshes; the air is then conducted over the transformer and filtered again before entering the cores. In spite of these precautions, the air is only brought in direct contact with the interior of the cores of the transformer and not with the parts carrying current. The cores are supported in the middle of their length to obviate any deformation due to the vibrations of the car. The transformer is suspended to the body of the car by draw-bolts, so that the lateral sheets are only used for lining purposes, and are not called upon to carry any load. A further addition of springs connecting to the body of the car did not appear to be necessary, because the present arrangement is similar to that adopted for the international sleeping cars, and should suffice to insure a long life for the insulating materials.

Cables.—The current is taken from each of the three feeding wires by two trolley bows in parallel. The upper part of each of these arms carries a number of aluminium rods attached by means of narrow plate springs. The masses of the individual rods must be sufficiently small to insure that they bear constantly against the wire. The head of the arm carrying the bow is pressed out of aluminium sheet, and is connected to the vertical base by rods, the base being mounted on ball bearings in the socket on the car. The bow is pressed against the wire by springs, the tension of which is regulated by means of cams. The current is carried by insulated leads from the head of the bracket to the foot of the arms that take the current, and is thence transmitted to the cables affixed to the roof of the car. The making or breaking of contact between the bows and the wires is effected from the interior of the car, so that the bows can be made dead before any person mounts to the roof. All high-tension conductors must have been subjected to an insulation test of 20,000 volts; but, notwithstanding



LONGITUDINAL AND CROSS SECTIONAL VIEWS OF THE CAR.



CAR MOUNTED ON ROLLERS FOR STATIONARY TEST.

this, they are placed on high-tension insulators, and are thus treated as if they were bare wires.

Safety fuses are fixed close to the single bow; these operate as soon as contact is made from any cause between any phase and the earthed car, and the car is thus freed from current by the melting of the fuse. The wires of both collector systems lead from the safety fuses to the high-tension cut-out. This cut-out is not requisite for controlling purposes, and serves merely to cut out the tension at the end of the run. The switch may be operated from the apparatus compartment, or from either of the driver's platforms, so that it serves also as a safety switch in the event of the proper switch failing to act as the result of an accident. The two branches of the current pass separately from this main switch to the transformers of the truck. Each of these circuits and transformers is protected by fuses. The low-tension conductors lead from the transformers through a switching device to the motors. On account of the play to be allowed between the truck and the car, in regard to both the lateral oscillation when running round curves and the vertical deflection due to the action of the springs, the cables had to be suspended from flexible supports; this was effected by hanging them from a strong girth or belt. The cables leading from the motors back to the starting device are secured in a similar way.

The switch above referred to effects the admission of the current to the motor casings from the transformers, and it also allows of the adjustment for either direction of the driving or the delivery of counter current. Again, the storage battery is connected from this point to the stator circuit of the motors when braking the car as an automobile, i. e., when braking independently of the overhead wire.

Driving the Car.—The car driver has only to operate one single hand wheel in order to carry out all the manipulations. By means of an indicator he can at any time ascertain the position of the apparatus, and by an ampere-meter he ascertains the load on the motors; another apparatus continually indicates the speed of the car. By the hand wheel the driver operates a shaft extending through the entire length of the car. The switch is operated from this shaft by means of a pair of bevel wheels and cam wheels. The movement of this cam gearing to the extent of one tooth effects the switching of the controlling cylinder to forward current, reverse current or braking action. On the left of the driver is the handle for the operation of the compressed-air brake and on his right there is another, a hand wheel, for the hand brake to be used in shunting. It is proposed to employ a number of different kinds of measuring apparatus on the trial trips, especially with the object of indicating the acceleration of the speed, of measuring the air resistance met with in head and cross winds and of measuring and registering the consumption of current.

[Continued from SUPPLEMENT, No. 1349, page 21625.]

ANTHROPOLOGY.*

By Prof. D. J. CUNNINGHAM, M.D.

THE insular district in the fœtal brain is a depressed area of an elongated triangular form. The general surface of the cerebrum occupies, all round about it, a more elevated plane, and thus the insula comes to be bounded by distinct walls, like the sides of a shallow pit dug out in the ground. The upper wall is formed by the lower margins of the frontal and parietal lobes, the lower wall by the upper margin of the temporal lobe, and the front wall by the frontal lobe. From each of these bounding walls a separate portion of cerebral cortex grows, and these gradually creep over the surface of the insula so as to overlap it, and eventually completely cover it over and exclude it from the surface, in the same way that the lips overlap the teeth and the gums. That which grows from above is called the *frontoparietal operculum*, while that which grows from below is termed the *temporal operculum*. These appear very early, and are responsible for closing over more than the hinder three-fourths of the insula. The lower or temporal operculum is in the first instance more rapid in its growth than the upper or fronto-parietal operculum, and thus it comes about that when their margins meet more of the insula is covered by the former than by the latter. So far the development is apparently precisely similar to what occurs in the ape. The slit or fissure formed by the approximation of the margins of these two opercula is called the Sylvian fissure, and it constitutes a natural lower boundary for the parietal and frontal lobes which lie above it. At first, from the more energetic growth of the lower temporal operculum, this fissure slants very obliquely upward and backward, and is very similar in direction to the corresponding fissure in the brain of the ape. But in the human brain this condition is only temporary. Now begins that downward movement of the parietal lobe and back part of the frontal lobe to which reference has been made. The upper or fronto-parietal operculum, in the later stages of fœtal life and the earlier months of infancy, enters into a growth antagonism with the lower or temporal operculum, and in this it proves the victor. The margins of the two opercula are tightly pressed together, and, slowly but surely, the fronto-parietal operculum gains ground, pressing down the temporal operculum, and thus extending the territory of the frontal and parietal districts. This is a striking process in the brain development of man, and it results in a depression of the Sylvian fissure or the lower frontier line of the frontal and parietal lobes. Further, to judge from the oblique direction of the Sylvian fissure in the brain of the ape, the process is peculiar to man; in the simian brain there is no corresponding increase in the area of cerebral cortex under consideration.

I do not think that it is difficult to account for this important expansion of the cerebral surface. In the fore part of the region involved are placed the groups of motor centers which control the muscular movements of the more important parts of the body. These occupy a broad strip of the surface which stretches across the whole depth of the district concerned. Within this are the centers for the arm and hand, for the face, the mouth and the throat, and likewise, to some extent, the center for speech. In man certain of these have undoubtedly undergone marked expansion. The skilled movements of the hands, as shown in the use of tools, in writing, and so on, have not been acquired without an increase in the brain mechanism by which these are guided. So important, indeed, is the part played by the human hand as an agent of the mind, and so perfectly is it adjusted with reference to this office, that there are many who think that the first great start which man obtained on the path which has led to his higher development was given by the setting of the upper limb free from the duty of acting as an organ of support and locomotion. It is an old saying "that man is the wisest of animals because of his hands." Without indorsing to its full extent this view, I think that it cannot be a matter for surprise that the district of the cerebral cortex in man in which the arm-centers reside shows a manifest increase in its extent.

In the same region of cerebral cortex, but at a lower level, there are also situated the centers which are responsible for facial expression. In the ape there is a considerable degree of facial play; but this is chiefly confined to the region of the lips; and the muscles of the face, although present in greater mass, show comparatively little of the differentiation which is characteristic of the lighter and more feeble muscles in the face of man. And then as to the effect produced: These human muscles are capable of reflecting every fleeting emotion, every change of mind, and by the lines and furrows their constant use indelibly fixes on the countenance the character and disposition of an individual can to some extent be read. As the power of communication between primitive men became gradually established, facial movements were no doubt largely used, not only for the purpose of giving expression to simple emotions, such as anger or joy, but also for giving point and force to the faltering speech of our early progenitors by reflecting other conditions of mind. The acquisition of this power as well as the higher and more varied powers of vocalization must necessarily have been accompanied by an increase of cerebral cortex in the region under consideration. And in this connection it is a point well worthy of note that the area of cortex mapped out in the human brain,* as controlling the muscles of the face, mouth, and throat is as large, if not larger, than that allotted to the arm and hand,† and yet it is questionable if all the muscles under the sway of the former would weigh as much as one of the larger muscles (say the triceps) of the arm. This is sufficient to show that it is not muscle power which determines the extent of the motor areas in the cerebral cortex. It is the degree of refinement in the movements required, as well as the degree of variety in muscle combinations, which apparently determines the amount of ground covered by a motor center.

Still, the increase in the amount of cerebral cortex in man due to the greater refinement of movement acquired by different groups of muscles is relatively small in comparison with the increase which has occurred in other regions from which no motor fibers are sent out, and which therefore have no direct connection with muscles.

The remarkable conclusions arrived at by Flechsig, although not confirmed and accepted in all their details, have tended greatly to clear up much that was obscure in the relations of the different districts of cerebral cortex. More particularly has he been able to apportion out more accurately the different values to be attached to the several areas of the cerebral surface. He has shown that fully two-thirds of the cortex in the human brain constitute what he terms "association centers." Within these the higher intellectual manifestations of the brain have their origin, and judgment and memory have their seat. They are therefore to be regarded as the psychic centers of the cerebral cortex.

Now, it requires a very slight acquaintance with the cerebral surface to perceive that the great and leading peculiarity of the human brain is the wide extent of these higher association centers of Flechsig. Except in connection with new faculties, such as speech, there has been relatively no striking increase in the extent of the motor areas in man as compared with the cortex of the ape or the idiot, but the expansion of the association areas is enormous and the increase in the frontal region and the back part of the parietal region is particularly well marked. It is this parietal extension of surface which is chiefly responsible for the pushing down of the lower frontier of the parietal lobe and the consequent enlargement of its territory.

I have already referred to the views which have been recently urged by several independent observers, that in the men who have been distinguished during life by the possession of exceptional intellectual power, this region has shown a very special development.

It is a curious circumstance, and one which is worthy of consideration, that in the left cerebral hemisphere the Sylvian fissure or the lower boundary of the parietal lobe is more depressed than in the right hemisphere, and, as a result of this, the surface area occupied by the parietal lobe is greater on the left side of the brain than on the right side. To the physiologist it is a matter of every-day knowledge that the left cerebral hemisphere shows in certain directions a marked functional pre-eminence. Through it the movements of the right arm and right side of the body are controlled and regulated. Within it is situated also the active speech center. This does not imply that there is no speech center on the right side, but simply that the left cerebral hemisphere has usurped the chief if not the entire, control of this all-important function, and that from it are sent out the chief part, if not the whole, of the motor incitations which give rise to speech. The significance attached to the dominant power of the left hemisphere receives force from the now well-established fact that in left-handed individuals the speech function is also transferred over to the right side of the brain. To account for this functional pre-eminence of the left cerebral hemisphere numerous theories have been elaborated. The interest attached to the subject is very considerable, but it is impossible on the present occasion to do more than indicate in the briefest manner the three views which have apparently had the widest influence in shaping opinion on this question. They are: (1) that the superiority of the left cerebral hemisphere is due to its greater weight and bulk; (2) that it may be accounted for by the greater complexity of the convolutions on the left brain and the fact that these make their appearance earlier on the left side than on the right side; (3) that the explanation lies in the fact that the left side of the brain enjoys greater advantages in regard to its blood supply than the right side.

Not one of these theories, when closely looked into, is found to possess the smallest degree of value. Braune‡ has shown in the most conclusive manner that if there is any difference in weight between the two hemispheres it is a difference in favor of the right and not of the left hemisphere; and I may add from my own observations that this is evident at all periods of growth and development. Equally untrustworthy are the views that have been put forward as to the superiority of the left hemisphere from the point of view of convolutionary development. I am aware that it is stated that in two or three cases where the brains of left-handed people have been examined this superiority was evident on the right hemisphere. This may have been so; I can only speak for the large percentage of those who are right-handed; and I have never been able to satisfy myself that either in the growing or fully developed brain is there any constant or marked superiority in this respect of the one side over the other; and I can corroborate Ecker (Archiv für Anthropologie, 1868, Bd. cxi) in his statement that there is no proof that the convolutions appear earlier on the one side than on the other. The theory that an explanation is to be found in a more generous blood supply to the left hemisphere is more difficult to combat, because the amount of blood received by each side of the brain depends upon two factors, viz., the physical conditions under which the blood-stream is delivered to the two hemispheres and the caliber of the arteries or tubes of supply. Both of these conditions have been stated to be favorable to the left hemisphere. It is a matter of common anatomical knowledge that the supply pipes to the two sides of the brain are laid down somewhat differently, and that the angles of junction, etc., with the main pipe are not quite the same. Further, it is true that the blood-drains which lead away the blood from the brain are somewhat different on the two sides. Whether this would entail any marked difference in the blood-pressure on the two sides I am not prepared to say. This could only be proved experimentally; but, taking all the conditions into consideration, I am not inclined to attach much importance to the argument. It is easy to deal with the loose statements which have been made in regard to the size of leading supply pipe (viz., the internal carotid artery). It passes through a bony canal in the floor of the cranium on its way into the interior of the cranial box. Its size can, therefore, be accurately gaged by measuring the sectional area of this bony tunnel on each side. This I have done in twenty-three skulls chosen at random, and the result shows that considerable differences in this respect are to be found in different skulls. These discrepancies, however, are sometimes in favor of the one side and at other times in favor of the other side; and when the combined sectional area for all the skulls examined was calculated it was, curiously enough, found to be 583½ square millimeters for the left side and 583 square millimeters for the right side.

Leaving out of count the asymmetry in the arrangement of the convolutions in the two hemispheres, which cannot by any amount of ingenuity be twisted into such a form as to give a structural superiority to one side more than the other, the only marked difference which appears to possess any degree of constancy is the increase in the territory of the left parietal lobe produced by the more marked depression of its lower frontier line (Sylvian fissure). That this is in any way associated with right-handedness or with the localization of the active speech center in the left hemisphere I am not prepared to urge, because the same condition is present in the ape. It is true that some authorities hold that the ape is right-handed as well as man, but in the gardens of the Royal Zoological Society of Ireland I have had a long and intimate experience of both anthropoid and lower apes, and I have never been able to satisfy myself that they show any decided preference for the use of one arm more than the other.

That differences do exist in the more intimate structural details of the two hemispheres, which give to the left its functional superiority, there cannot be a doubt; but these have still to be discovered. Bastian has stated that the gray-cortex on the left side has a higher specific gravity, but this statement has not as yet received corroboration at the hands of other observers.

I have already mentioned that man's special endowment, the faculty of speech, is associated with striking changes in that part of the cerebral surface in which the motor center for articulate speech is located. It is questionable whether the acquisition of any other system of associated muscular movements has been accompanied by a more evident cortical change. The center in question is placed in the lower and back part of the frontal lobe. We have seen that the insular district is covered over in the hinder three-fourths of its extent by the fronto-parietal and temporal opercula, and thus submerged below the surface and hidden from view. The brain of the ape and also of the microcephalic idiot with defective speech goes no further in its development. The front part of the insular district remains uncovered and exposed to view on the surface of the cerebrum. In man, however, two additional opercula grow out and ultimately cover over the front part of the insula. These opercula belong to the lower and back part of the frontal lobe, and are to be looked

* Opening address by the President of the Section, before the Meeting of the British Association at Glasgow.

* See diagram in Schafer's article on the "Cerebral Cortex" in his recent work on physiology.

† The comparison only refers to surface area, and this is not an absolutely true criterion of the relative amount of cortex in each region. The arm-center has a large amount of cortex stowed away within the fissure of Rolando in the shape of inter-locking gyri which is not taken into account in a measurement confined to the superficial surface area. Still, this does not to any great degree detract from the argument which follows, seeing that the discrepancy is still sufficiently marked.

‡ "Das Gewichtsverhaltniss der rechten zur linken Hirnhälfte beim Menschen." (Archiv fur Anat.)

† Ogle, "On Dextral Pre-eminence," Trans. Med. Chirurg. Soc., 1870. Aimé Fère, "Les Courbures Iterales normales au rachis humain" (Toulouse, 1900.)

upon as being more or less directly called into evidence in connection with the acquisition of articulate speech.

The active speech center is placed in the left cerebral hemisphere. We speak from the left side of the brain, and yet when the corresponding region* on the right side is examined it is found to go through the same developmental steps.

The stimulus which must have been given to general cerebral growth in the association areas by the gradual acquisition of speech can hardly be exaggerated.

During the whole course of this evolution there is no possession which man has contrived to acquire which has exercised a stronger influence on his higher development than the power of articulate speech. This priceless gift, "the most human manifestation of humanity" (Huxley) was not obtained through the exertions of any one individual or group of individuals. It is the result of a slow process of natural growth, and there is no race, no matter how low, savage or uncultured, which does not possess the power of communicating its ideas by means of speech. "If in the present state of the world," says Charma, "some philosopher were to wonder how man ever began to build those houses, palaces and vessels which we see around us, we should answer that these were not the things that man began with. The savage who first tied the branches of shrubs to make himself a shelter was not an architect, and he who first floated on the trunk of a tree was not the creator of navigation." And so it is with speech. Rude and imperfect in its beginnings, it has gradually been elaborated by the successive generations that have practised it.

The manner in which the faculty of speech originally assumed shape in the early progenitors of man has been much discussed by philologists and psychologists, and there is little agreement on the subject. It is obvious that all the more intelligent animals share with man the power of giving expression to certain of the simpler conditions of mind, both by vocal sounds and by bodily gestures. These vocal sounds are of the interjectional order, and are expressive of emotions or sensations. Thus the dog is said, as a result of its domestication, to have acquired the power of emitting four or five different tones, each indicative of a special mental condition and each fully understood by its companions. The common barn-door fowl has also been credited with from nine to twelve distinct vocal sounds, each of which is capable of a special interpretation by its fellows or its chickens. The gestures employed by the lower animals may in certain cases be facial, as expressed by the grimaces of a monkey, or changes in bodily attitude, as we see continually in the dog.

I think that it may not be unreasonably inferred that in the distant past the remote progenitors of man relied upon equally lowly means of communicating with their fellows, and that it was from such humble beginnings that speech has been slowly evolved.

There cannot be a doubt that this method of communicating by vocal sounds, facial expression and bodily gestures is capable of much elaboration; and, further, it is possible, as some hold, that it may have attained a considerable degree of perfection before articulate speech began to take form and gradually replace it. Much of it, indeed, remains with us to the present day. A shrug of the shoulders may be more eloquent than the most carefully prepared phrase; an appropriate expression of face, accompanied by a suitable ejaculation, may be more withering than a flood of invective. Captain Burton tells us of a tribe of North American Indians whose vocabulary is so scanty that they can hardly carry on a conversation in the dark. This and other facts have led Mr. Tylor, to whom we owe so much in connection with the early history of man, to remark: "The array of evidence in favor of the existence of tribes whose language is incomplete without the help of gesture-signs, even for things of ordinary import, is very remarkable"; and, further, "that this constitutes a telling argument in favor of the theory that gesture-language is the original utterance of mankind out of which speech has developed itself more or less fully among different tribes." It is a significant fact, also, as the same author points out, that gesture-language is, to a large extent, the same all the world over.

Many of the words employed in early speech were undoubtedly formed, in the first instance, through the tendency of man to imitate the natural sounds he heard around him. To these sounds, with various modifications, was assigned a special conventional value, and they were then added to the growing vocabulary. By this means a very decided forward step was taken, and now primitive man became capable of giving utterance to his perceptions by imitative sounds.

Max Müller, although bitterly opposed to the line of thought adopted by the "Imitative School" of philologists, has expressed their views so well that I am tempted to use the words he employed in explaining what he satirically branded as the "Bow-wow Theory." He says: "It is supposed that man, being yet mute, heard the voices of the birds, dogs, and cows, the roaring of the sea, the rustling of the forest, the murmur of the brook, and the whisper of the breeze. He tried to imitate these sounds, and finding his mimicking cries useful as signs of the object from which they proceeded, he followed up the idea and elaborated language."

Hood† humorously and unconsciously illustrates this doctrine by a verse descriptive of an Englishman, ignorant of French, endeavoring to obtain a meal in France:

> "Moo!" I cried for milk;
> If I wanted bread
> My jaws I set agoing;
> And asked for new-laid eggs
> By clapping hands and crowing.

But, although much of early articulate speech may have arisen by the development of interjectional sounds and the reproduction, by the human vocal organs, of natural sounds, it is very unlikely that these afforded the only sources from which words were originally derived. Romanes insists upon this, and, in support of his argument, refers to cases where children invent a language in which apparently imitative sounds take no part. He likewise alludes to the well-known fact that deaf mutes occasionally devise definite sounds which stand for the names of friends. In the light of such evidence, he very properly asks, "Why should it be held impossible for primitive man to have done the same?"

The value of spoken language, as an instrument of thought, is universally admitted, and it is a matter incapable of contradiction that the higher intellectual efforts of man would be absolutely impossible were it not for the support which is afforded by articulate speech. Darwin expresses this well when he says: "A complex train of thought can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or symbols." Such being the case, I think we may conclude that the acquisition of speech has been a dominant factor in determining the high development of the human brain. Speech and mental activity go hand in hand. The one has reacted on the other. The mental effort required for the coining of a new word has been immediately followed by an increased possibility of further intellectual achievement through the additional range given to the mental powers by the enlarged vocabulary. The two processes, mutually supporting each other and leading to progress in the two directions, have unquestionably yielded the chief stimulus to brain development.

More than one philologist has insisted that "language begins where interjection ends." For my part I would say that the first word uttered expressive of an external object marked a new era in the history of our early progenitors. At this point the simian or brute-like stage in their developmental career came to an end and the human dynasty endowed with all its intellectual possibilities began. This is no new thought. Romanes clearly states that in the absence of articulation he considers it improbable that man would have made much psychological advance upon the anthropoid ape, and in another place he remarks that "a man-like creature became human by the power of speech."

The period in the evolution of man at which this important step was taken is a vexed question, and one in the solution of which we have little solid ground to go upon beyond the material changes produced in the brain and the consideration of the time that these might reasonably be supposed to take in their development.

Darwin was inclined to believe that articulate speech came at an early period in the history of the stem-form of man. Romanes gives a realistic picture of an individual decidedly superior to the anthropoid ape, but distinctly below the existing savages. This hypothetical form, half-simian, half-human, was, according to his sponsor, probably erect; he had arrived at the power of shaping flints as tools, and was a great adept at communicating with his fellows by gesture, vocal tones, and facial grimaces.

With this accomplished ancestor in his mental eye it is not surprising that Romanes was inclined to consider that articulate speech may have come at a later period than is generally supposed.

At the time Romanes gave expression to these views he was not acquainted with the very marked structural peculiarities which distinguish the human brain in the region of the speech center. I do not refer to the development of the brain in other districts, because possibly Romanes might have held that the numerous accomplishments of his speechless ancestor might be sufficient to account for this; I merely allude to changes which may reasonably be held to have taken place in direct connection with the gradual acquisition of speech.

These structural characters constitute one of the leading peculiarities of the human cerebral cortex, and are totally absent in the brain of the anthropoid ape and of the speechless microcephalic idiot.

Further, it is significant that in certain anthropoid brains a slight advance in the same direction may occasionally be faintly traced, while in certain human brains a distinct backward step is sometimes noticeable. The path which has led to this special development is thus in some measure delineated.

It is certain that these structural additions to the human brain are no recent acquisition by the stem-form of man, but are the result of a slow evolutionary growth—a growth which has been stimulated by the laborious efforts of countless generations to arrive at the perfect co-ordination of all the muscular factors which are called into play in the production of articulate speech.

Assuming that the acquisition of speech has afforded the chief stimulus to the general development of the brain, and thereby giving it a rank high above any other factor which has operated in the evolution of man, it would be wrong to lose sight of the fact that the first step in this upward movement must have been taken by the brain itself. Some cerebral variation—probably trifling and insignificant at the start, and yet pregnant with the most far-reaching possibilities—has in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other.

MAGNETIC PROPERTIES OF NEW IRONS.—E. Gumlich and E. Schmidt, of the Reichsanstalt, have collected a large amount of valuable material in regard to the various new types of iron and steel lately introduced, such as Kohlswa iron, Remscheid dynamo steel, Gelsenkirchen cast steel, and Böhler and Remscheid tungsten steel. The last shows the greatest hysteresis, and the greatest permeability is shown by Kohlswa iron No. 52, annealed five times over. The figures are 3,680 for the permeability of the latter and 3,240 for the permeability of Remscheid dynamo steel. Measurements extending over some 46 specimens bring out a clear relation between hysteresis, resistance, and the other magnetic properties. The rule holds good with few exceptions that a high hysteresis loss means a high electric resistance, a greater remanent magnetism, a greater coercive force, and a lesser maximum permeability. The authors mention a new material of secret composition which forms a striking exception. It has a higher resistance than hardened steel, shows an extraordinary remanence and maximum permeability, and at the same time a small coercive force and hysteresis loss. This specimen, labeled No. 15, guarantees a small loss both from hysteresis and from eddy currents in dynamos.—Gumlich and Schmidt, Elektrotechn. Zeitschr., 35, 1901.

ADDRESS IN GEOGRAPHY BEFORE THE BRITISH ASSOCIATION.

THE Address in Section E, by Dr. Hugh Robert Mill, D.Sc., LL.D., F.R.S.E., F.R.G.S., dealt with Research in Geographical Science. Hitherto, except as regards exploration and cartography, the position of geography in this country has never been satisfactory. It has sometimes been hinted that the study of geography has been deliberately discouraged by politicians or by merchants, because too much knowledge on the part of the public might embarrass foreign policy or lead to foreign competition; but we surely cannot entertain such unworthy suspicions. I am inclined to attribute the neglect of the subject merely to ignorance of its nature due to imperfect education. Two cases in which the application of geography to political and practical affairs suggests a definite course of action may be mentioned as examples. There is still one important colonial boundary entirely undelimited in a region somewhat difficult of access and still little known, where goldfields will probably be found or reported before long, and where a very serious international question may suddenly arise in a part of the world absolutely unsuspected by most people, even among those who interest themselves in general politics and in colonial affairs. It would cost a comparative trifle to survey the region in question, and to lay down that boundary line before the gold fields are touched, so that no international trouble could ever arise. What it may cost to postpone the matter until claims have been pegged out on debatable land, the British Guiana and Venezuela arbitration, the Alaska difficulty, and South Africa are there to tell us. It would be interesting to calculate, now that the cost of a week of fighting is known, the saving in pennies on the income tax that would have accrued from a survey of South Africa if that had been carried out as an imperial duty when Cape Colony was settled. The second example comes nearer home. The utilization of wind and water power must increase in importance as mineral fuel diminishes in amount or increases in price. Wind and water power will never fail as long as the sun shines and the land remains higher than the sea; but what may fail unless timely precautions are taken is the power of utilizing them for the benefit of the community at large. Are the existing laws as to water rights, and the absence of laws as to the utilization of wind, desirable and satisfactory? The usual answer to such questions is: "Why trouble about that just now? These matters are not urgent, other things are." That argument is answerable for many disasters. The inevitable is in many, if not in most, cases simply another name for the unforeseen. It is inevitable that the country will be impoverished if the utilization of wind and water power and the transport of that power by electricity are not wisely safe-guarded and provided for; but when a survey of our resources, the circulation of the air over our islands, and the effects produced by the interposition of the mountains, plateaus, and valleys upon it, plainly points to the possibility of such a trouble, it only becomes inevitable as a result of culpable negligence.

A PROPOSED REMEDY.

The few attempts which have been made in this country to promote the study of geography or to diminish the discouragements to geographical research have had but slight success. If a chair of Geography were instituted with the purpose of promoting research first and teaching afterward, properly equipped with books, maps, and apparatus, and held on the understanding that no outside work was to be undertaken, something might yet be done to restore our country to the position it held a century and a half ago, when a text-book of geography was published without a thought of sarcasm, containing a frontispiece representing "Britannia instructing Europe, Asia, Africa, and America in the Science of Geography."

MARBLE IN ALASKA.

J. E. CRONIN, who has recently returned from Marble Creek, on Prince of Wales Island, and W. K. Sheldon, who has just joined him from San Francisco, have some wonderful stories to tell of the fine character of the marble to be found at Shakan, on Prince Edward Island. The marble is said to be equal to the best Italian marble. Mr. Sheldon said: "When I received samples of this marble last February I saw at once that it was unlike any marble now being produced in the United States, but identical with the marble produced in the world-famous quarries of Carrara, Italy. While there are a number of profitable quarries in the United States and a large amount of American marble is used, yet the Italian product has always occupied a field which no American marble could fill, as evidenced by the fact that during the fiscal year ended June 30, 1900, nearly 40,000 tons of Italian marble were imported into the United States. This marble from Alaska, in texture, color and chemical analysis, is identical with the Carrara deposit, and there is no reason why it should not supplant the foreign product entirely. I went to Alaska in March and found a mountain of high-grade marble. While I was fully convinced as to the quality of the material, I did not wish to make a final report on the property as a commercial proposition until large blocks had been quarried, taken to the market, and sawed. We, therefore, quarried a number of blocks, and I took them to San Francisco and had several of them sawed. These blocks, of course, were taken from the surface of the ground, and, having been subjected to climatic influences for several centuries, were soft for a depth of several inches from the surface; but the trial demonstrated the fact that the deposit is a remarkably sound one, and I have every

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* Rudinger and others have tried on very unsubstantial grounds to prove that there is a difference in this region on the two sides of the brain. There is, of course, as a rule, marked asymmetry; but I do not think that it can be said with truth that the cortical development of the region is greater on the left side than on the right.

† From "The Origin of Language," by Hensleigh Wedgwood, 1866.

reason to believe that the percentage of high-grade sound marble will be much larger than in any of the deposits now being worked in the United States. In fact, when you consider that in developing marble quarries it is customary to take out and throw away from 10 to 20 feet of the surface material, the results obtained are unprecedented. The amount of the matter is that on an island in southeastern Alaska, within a few feet of deep water, there is a larger area of high-grade marbles than the combined areas of all the quarries now being worked in the United States."—Seattle Post-Intelligencer.

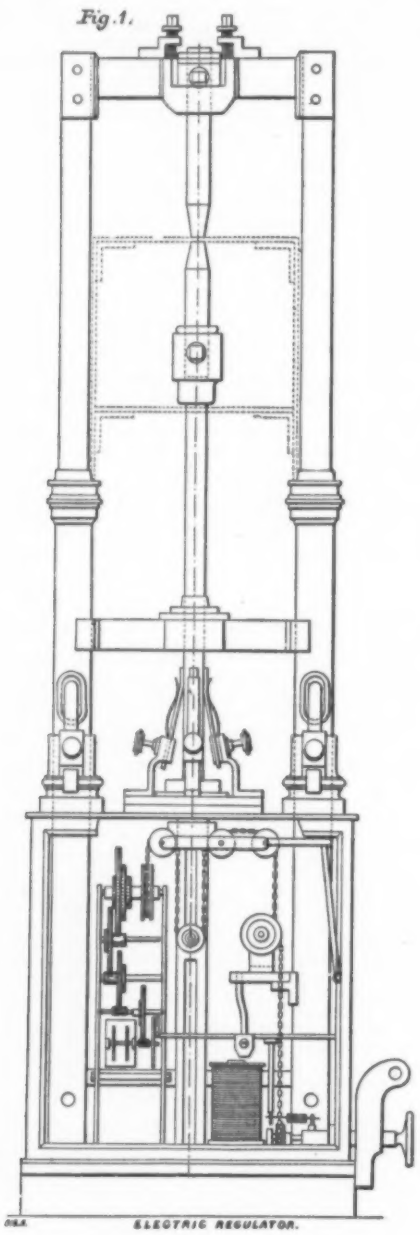
RECENT IMPROVEMENTS IN THE LIGHTING AND BUOYING OF THE COASTS OF FRANCE.*

By BARON QUINETTE DE ROCHEMONT, Inspecteur-Général des Ponts et Chaussées, Directeur du Service des Phares, M. Inst. C. E.

INCREASE IN THE ILLUMINATING POWER OF LIGHTHOUSES.

THE illuminating power of lighthouses has been increased by: (1) Increasing the intrinsic brightness of the luminous source; (2) greater perfection in the manufacture of the optical apparatus; (3) reducing the number of lenticular panels, and increasing their surface and power by employing lightning lights.

Fig. 1.



ELECTRIC REGULATOR.

The brightness of the beam from a lenticular panel is proportionate to the intrinsic brightness of the luminous source at the burner, and not to the luminous intensity. The mean intrinsic brightness of flames produced by oil lamps increases only to a slight extent with the size of the flames; consequently, the light efficiency diminishes, while the expense is greater, and the services more irksome. The illuminating power of lighthouses can therefore only be improved to a slight extent by increasing the number of wicks.

The adoption of Aüer incandescent burners for compressed gas and petroleum vapor has enabled a great improvement to be effected in practice. Incandescent lighting by acetylene gas will probably give even better results, at any rate, as regards light efficiency; acetylene lighting, however, is only at present in its experimental stage. The trials carried out at the central lighthouse works have been sufficiently thorough to enable this method of lighting to be shortly applied to the Chassiron Lighthouse in the Charente-Inférieure. Electric light, which has a far greater intrinsic brightness than incandescent light, has only been adopted in the thirteen most important lighthouses protecting the principal headlands, on account of the great expense it entails.

The intrinsic brightness, in a horizontal direction, of various systems of lighting employed in lighthouses is as follows, expressed in carcels per square centimeter of the mean horizontal focal plane of the luminous source:

	Carcels.*
Burner with mineral oil and 1 wick....	0.35
" " 2 wicks...	0.50
" " 3 wicks...	0.80
" " 4 wicks...	0.95
" " 5 wicks...	1.10
" " 6 wicks...	1.18
Incandescent lighting with compressed oil gas.....	2.00
Incandescent lighting with petroleum vapor	2.50
Incandescent lighting with acetylene..	4.00
Crater of the electric arc.....	900.00

The luminous efficiency of the optical apparatus has been considerably increased within recent years. Experience has shown that there is no advantage in prolonging the duration of the flash beyond one-tenth of a second, which is about the minimum time required for full perception, and that an average interval of five seconds between the flashes is sufficient to enable seamen to get their bearings. By reducing the duration of the flashes, as far as possible to the time actually required for the full perception of their luminous intensity, it has been possible to construct the optical apparatus with a small number of lenses of large surface, and consequently of great power. This new optical apparatus is much less bulky and cheaper than the corresponding apparatus of the old types. The period of revolution of this apparatus is consequently rapid, occupying only from 5 to 25 seconds. This unprecedented speed, especially for first-order lighthouses, is obtained by means of simple mechanical contrivances and light clock-work mechanism.

In the case of lights with flashes at regular intervals, the optical apparatus has even been made with a single set of lenses, covering a semicircle in plan, the hinder half of the rays being thrown back into the luminous beam by a reflector. This arrangement utilizes two-thirds of the total light, and gives an efficiency that had never been attained in flash lights; but, owing to the velocity of rotation required, it is necessary to give the beam a large horizontal divergence. With two sets of lenses, each occupying a semi-circle, half the total light can be utilized; and this type of apparatus is suitable for lenses with a long focal distance.

Fig. 2.

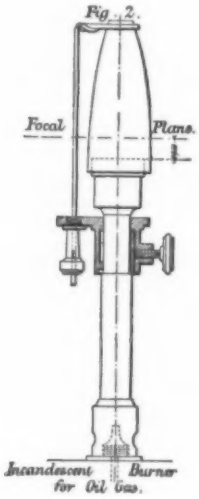


Fig. 3.

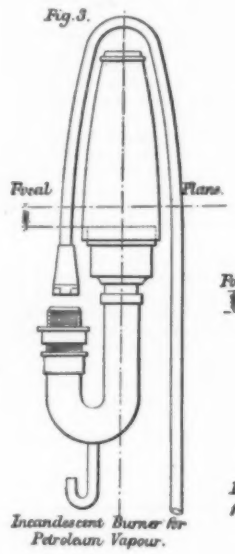


Fig. 4.

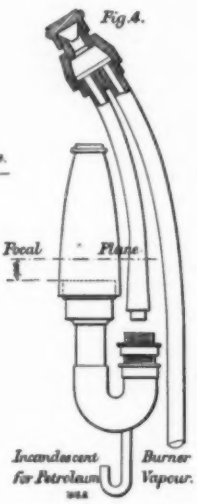
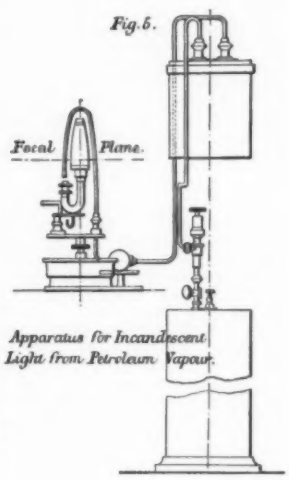


Fig. 5.



ELECTRIC LIGHTS.

The illuminating power of electric lighthouses is so great that there is no occasion to seek to increase it; nevertheless, some important improvements have been made in this method of lighting. In lighthouses with a single set of optical apparatus, such as those of La Hêve and of the island of Yeu, there are three powers of light, produced by currents of 25, 50, and 100 amperes at 45 volts. In lighthouses with a double set of optical apparatus, such as at Eckmühl and Créac'h, there are only two powers, produced by currents of 25 and 50 amperes each. The power of 25 amperes, with which the efficiency of the optical apparatus is comparatively feeble, owing to the extreme smallness of the light, is only used during very clear weather. With a double set of optical apparatus, the two arcs of 50 amperes are almost in constant use and absorb the whole power of the two dynamos which have hitherto been employed.

The new regulator (Fig. 1) consists of a box with two glazed sides, which contains the mechanism. Three guiding uprights are fixed to the box; the central is isolated, and the two outer ones are connected together by a cross-piece. These uprights are slit vertically, and have brushes which convey the current to the sliding rods. These bronze rods slide up and down these uprights; the two outer rods are connected at each extremity by a cross-piece; the upper cross-piece has a carbon-holder which is designed so as to enable the upper carbon to be fixed in position; the central rod carries an ordinary carbon-holder. Clockwork mechanism with a regulating electromagnet moves the rods simultaneously, and controls the movements of the carbons so that they are displaced at the same rate as they are burnt.

INCANDESCENT LIGHTING WITH COMPRESSED GAS OR PETROLEUM VAPOR.

The light given by Aüer mantles, heated by gas to incandescence, has such great intrinsic brightness, that the Lighthouse Department has been induced to try this system of illumination.

Incandescence with low-pressure gas only gives a comparatively feeble intrinsic brightness. Compressed gas must be used in order to obtain a greater intrinsic brightness than that afforded by the largest petroleum burners in use. With compressed gas, the quantity of gas supplied to the mantle, and the rate of combustion, vary in proportion to the pressure; while the dimensions of the incandescent light remain unaltered. The temperature of the mantle and its intrinsic brightness are therefore gradually increased. To overcome the objectionable condensation which occurs when coal gas is used, even at low pressures, the Pintsch gas, which is already in use for lighting buoys, has been adopted. This gas can bear a pressure of 10 or 12 kilogrammes (140 pounds to 168 pounds) without condensation, so that it can be stored in small portable reservoirs.

The burner (Fig. 2) employed consists of a vertical tube, with a Bunsen burner and Aüer mantle at the top; an ejector for the compressed gas is placed at the bottom of the tube. For proper combustion the volume of air supplied to the mantle must be eight times that of the gas. The pressure of the gas is 0.16 kilogramme per square centimeter (2.24 pounds per square inch); the rate of consumption of gas is 160 liters (5.65 cubic feet) per hour, and 4.5 liters (274.6 cubic inches) per hour per carcel. A regulator supplies the gas at constant pressure, so that a luminous source of almost constant intensity can be obtained, with occasional instead of constant supervision. This system has been adopted for several first-order lighthouses (Chassiron, Ile de Sein, Ile de Groix), for the Ar-men lighthouse out at sea, and for the Ailly lighthouse.

The necessity of building works for supplying the oil gas has limited the application of incandescent gas lighting to a few important lights. The Lighthouse Department, therefore, has endeavored, with success, to obtain the same advantages, for a slight outlay, by substituting petroleum vapor for incandescent lighting. The burners employed are all made on the same principle, but their arrangements differ slightly according to the type of lighting apparatus for which they are intended. This principle consists in injecting the liquid petroleum into a vaporizer, heated by the mantle; the vapor then passes into the Bunsen burner of the mantle, after mixing with the air required for combustion. In starting, the vaporizer is heated by a spirit flame to the required temperature.

If the type of optical apparatus permits, the vaporizer is made in the form of an inverted U (Fig. 3), with its extremities placed as near as possible to the mantle. When the optical apparatus does not permit of the above arrangement for the vaporizer, or where a fixed burner is employed, the optical apparatus being alone movable, the tube conveying the petroleum is placed against the vaporizer (Fig. 4). The two tubes thus cast a single shadow, which can be thrown into the dark arc of lightning lights with group flashes, or into the landward arc in the case of the old type of apparatus. The adoption of larger mantles and of vaporizers with flattened tubes, now on trial, will tend in future to limit the use of burners of the type represented in Fig. 4. These burners only require the addition of a petroleum reservoir of a minimum capacity of 4 liters (244 cubic inches), which is connected with another reservoir of at least double the capacity, filled with air at a pressure of 6 kilogrammes (84 pounds) (Fig. 5). A regulator maintains the pressure of the air upon the petroleum to at least 2 kilogrammes (28 pounds). The consumption of petroleum is as low as 4 grammes (0.147 ounce) per hour per carcel of light intensity in the mantle. A consumption of 5 grammes (0.175 ounce), however, is assumed in practice, and this is much lower than that of any lamp hitherto employed. The total rate of consumption per hour is therefore 175 grammes (6.172 ounces).

Petroleum vapor is employed as an illuminant for the lighthouses of Four (Finistère), of Roches Douvres, and of the Grand Charpentier, all of which are situated out at sea; for the leading lights of Graves, St. Georges, Trézien, and St. Mathieu, and for the flash-lights of the Island of Batz, of Kermorvan, of Poulains, and of Camarat. This illuminant will also be adopted for the lighthouses of Cape Béar, of the Mont St. Clair, and of the Ile Vierge, now in course of construction.

PERMANENT LIGHTS.

The Lighthouse Department has taken steps to protect navigation by illuminating the beacon towers and shoals out at sea, where the erection of ordinary lighthouses is precluded on account of the expense. This

* Paper read before the International Engineering Congress, Glasgow, 1901. Section II. Waterways and Maritime Works.

* 1 carcel = 9.5 candles.

has been carried out by means of small single-wick lights with ordinary mineral oil, which can burn for several months without having to be attended to. The wicks used for this purpose are specially prepared, the surface of the wick being evenly coated with a thin layer of carbonized tar, the operation being termed *croûtage*, or caking. The luminous intensity of these lights, which is equivalent at the outset to two carcels, diminishes gradually till, at the end of two months, it is only equal to one carcel. Excellent results are obtained, but, like all unattended lights, they afford less security to navigation than the ordinary ones. This system has been applied to such an extent that it was necessary to give these lights all the characteristics of attended lights. This has been effected by adopting the system of flotation in a mercury bath, employed with lightning lights, which enable the apparatus to be easily revolved.

LIGHTSHIPS.

The information afforded by various trials and experiments has been utilized for the design of the lightship which is to be moored on the "Sandettié." These designs have been made by the Central Lighthouse Department, assisted by Mr. Terré, ingénieur en chef de la marine. A series of observations taken during three consecutive months (July 11 to October 31, 1900), at the site proposed for the new lightship, show that the motion of the sea at this point is precisely similar to that at the anchorage of the Ruytingen lightship, and that the half period of oscillation of heavy waves is about two and a half seconds. The principal dimensions of the Ruytingen lightship, which has afforded satisfactory results, have therefore been taken as a basis, and modified, where necessary, in accordance with the results of the observations and experiments referred to above. The main dimensions of the vessel have, consequently, been fixed as follows:

Length over all	35.00 m.	(114 ft.	10 in.)
Width at the water-line	6.24 "	(20 "	5 ")
Depth from deck to bottom of hold at center	5.10 "	(16 "	8½ ")
Depth from water-line to bottom of hold at center	3.60 "	(11 "	9½ ")
Projection of the keel and false keel in the middle	1.00 "	(3 "	3 ")
Mean draught, when loaded	4.60 "	(15 "	1 ")
Depth of side keels at center	0.80 "	(2 "	7½ ")
Displacement	342 tons.		

The metacentric leverage transversely is 0.393 meter (1.29 feet), and 30.36 meters (99.58 feet) longitudinally. The hull is divided into six compartments by five watertight partitions across the ship. The two compartments at either end are separated into an upper and a lower chamber by a wooden deck. The compressed-air reservoirs for the sounding signal and the gas reservoir for illumination are placed in the third compartment from the bow; the boilers, the machinery for the sounding signal, and the coal bunkers are in the fourth compartment. The crew's quarters are in the second compartment, and the officers' quarters are in the fifth. The latter contains water cisterns of a capacity of 10 *tonneaux* (2,200 gallons). The end compartments, fore and aft, are used as storerooms for sails and ropes. The captain's cabin, the chamber for the sounding signal, and the cook's galley are placed on deck amidships, where the gangways leading down to the four central compartments are also situated. The lantern is carried on a hollow iron mast of 0.75 meter (2.46 feet) internal diameter; access is provided by two doors in the mast—one on deck level and another in the machinery room. The sails consist of a jib and mainsail, the latter hoisted along an iron upright parallel to the mast, and of a jigger attached to a special mast. There are four anchors: a mushroom anchor weighing 2,000 kilogrammes (4,400 pounds), two anchors of 700 kilogrammes (1,540 pounds) for the catheads, and a cast-iron sinker of 120 kilogrammes (264 pounds).

The mooring cables are 0.042 meter (1.654 inches) in diameter, and 300 meters (984 feet) long. Two steel hawse-holes are provided in the bulwarks for the sheet anchors. Another cylindrical hawse-hole, in the center of the bow, connected with the stem slightly above the water-line when loaded, is provided for mooring the ship. The lightship has two small lifeboats, 6 meters (19.68 feet) and 5.75 meters (18.86 feet) long respectively, provided with air chambers.

The illuminating portion consists of a swinging optical apparatus for a lightning-light, giving out white flashes at regular intervals of five seconds. The optical apparatus, which has four panels of 0.25 meter (9.84 inches) focal distance, is provided at the lower part with a rod carrying a counterweight. This rod is fixed by means of a *Cardan* joint, below the apparatus, in the center of a horizontal ring rolling on steel ball bearings and operated by the rotating machine. Another counterweight is placed at the top of the apparatus. This apparatus weighs 700 kilogrammes (1,540 pounds), and is so designed that its center of gravity is 0.015 meter (0.591 inch) below the point of suspension. Under these conditions, the period of a single oscillation of the apparatus is about 8 seconds. The difference between this and a half period of the roll of the ship is such that the divergence of the apparatus from the vertical is less than 5 deg. to 6 deg., and the illumination is not affected thereby. The illuminant for incandescent lighting is compressed oil gas. It is conveyed through a pipe running up the mast, and when it reaches the top it passes through a mercury joint into a small tube, which turns exactly at the same rate as the apparatus, by means of a train of wheels operated by the rotating machine. This small tube is connected by a rubber pipe to the lower rod of the apparatus, which has a hole running up the center for the passage of the gas to the burner. The illuminating power is 3,500 carcels. The gas is stored in three reservoirs, which are tested at a pressure of 8 kilogrammes (112 pounds); two of the reservoirs have a capacity of 6,300 cubic meters (8,240 cubic yards), and the third a capacity of 5,200 cubic meters (6,801 cubic yards).

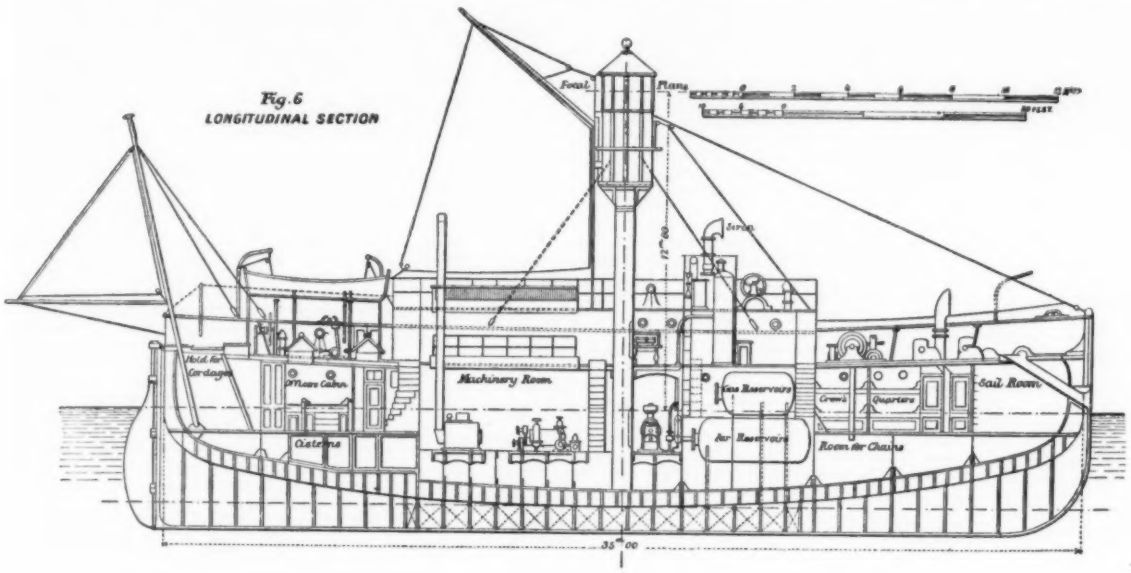
In addition to the illuminating apparatus, the lightship has to be provided with a plant for the sounding signal. This comprises two boilers with distilling plant, self-condensers, and air-compressors; and a single siren worked by compressed air, with reservoirs and accessories. The boilers and condensers are also used for working the steam windlass on board. These boilers are of the type adopted for the 50 horse power engines of scouting or dispatch steam launches of the French navy; they have an internal firebox, a direct flame, with forced draught by means of a steam jet into the flue, and a distilling boiler tube. The self-condensers have a single-cylinder steam engine, which operates an air pump, two feed pumps, the pumps for the recuperator of distilled water, and the centrifugal pump for maintaining the circulation of the water. The air-compressing plant consists of a steam engine working a compressing pump with two pistons, and a pump for maintaining the circulation of the sea water. The compressing pumps are designed to work at will, either at a pressure of 15 kilogrammes (210 pounds), or at 2 kilogrammes (28 pounds).

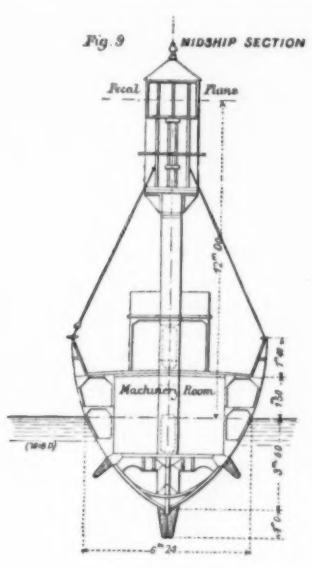
The sounding signal is a single-note siren, requiring 400 liters (14.12 cubic feet) of air per second; the pitch of the note corresponds to 330 vibrations per second. The rotating machine causes the siren to emit a sound of three seconds' duration, alternating every 90 seconds with a series of three notes, each of three seconds' duration, with intervals of three seconds between each note. There are two reservoirs for storing the necessary air for starting the apparatus instantaneously; they have each a capacity of 8,150 cubic meters (10,660 cubic yards), and are tested at a pressure of 15 kilogrammes (210 pounds).

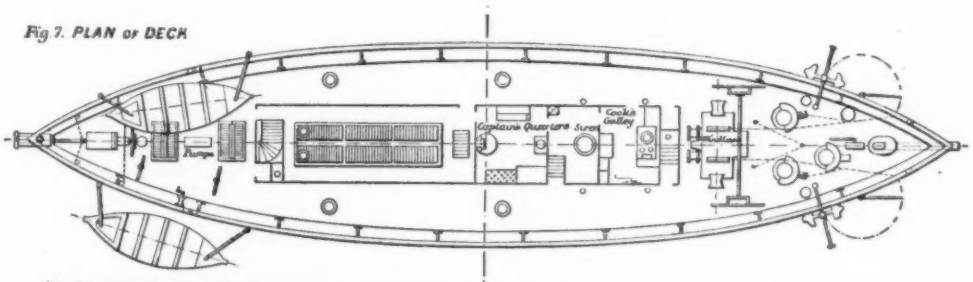
The Sandettié lightship and accessories will cost 340,000 francs (£13,600). This estimate is arrived at as follows:

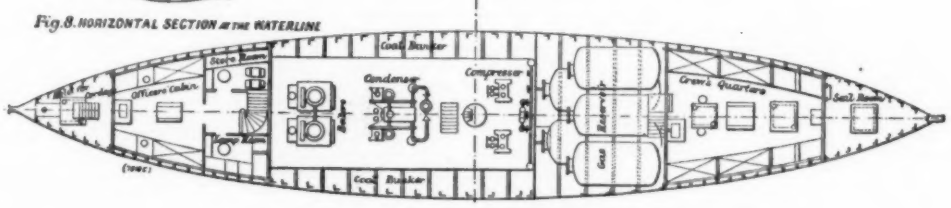
	Francs.	Pounds.
Hull, including cable and anchor gears, etc.	225,000	9,000
Optical apparatus and gas reservoirs.	33,000	1,320
Boilers and self-condensers	30,000	1,200
Sounding signal apparatus and air reservoirs	22,000	880
Air compressors	17,000	680
Erection, and various items	13,000	520

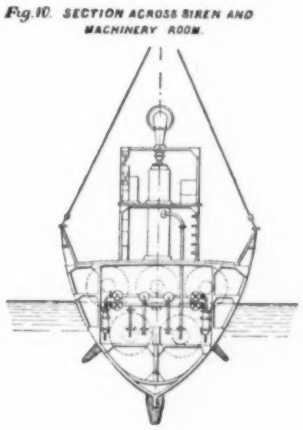
The crew will consist of a captain and a mate, who will succeed one another on board every alternate fortnight; twelve seamen, eight of whom will be on board and four on land, so that each seaman will in turn spend a month on board and a fortnight on land; two mechanics to attend to the engines, who will succeed one another on board in rotation every 15 days.











THE "SANDETTIÉ" LIGHTSHIP.

REFLEX ACTION AND INSTINCT.*

By W. BENTHALL, M.B.

IN the Paris Journal of Anatomy and Physiology of 1869 there was reported by Robin an experiment on the body of a criminal whose head had been removed an hour previously, at the level of the fourth cervical vertebra. The skin around the nipple was scratched with the point of a scalpel. Immediately there ensued a series of rapid movements in the upper extremity which had been extended on the table. The hand was brought across the chest to the pit of the stomach, simultaneously with the semi-flexion of the forearm and inward rotation of the arm, a movement of defense, as it were.

Probably none of us have seen quite so impressive an illustration of reflex action as the above, but most of us have watched the experiment in which a frog, having been decapitated and a drop of acid applied to its skin, the foot of the same side is brought up to wipe away the acid, and if this foot be cut off, after some ineffectual efforts and a short period of hesitation, the same action will be performed by the foot on the opposite side. These symptoms of apparently purposive action on the part of a brainless body have always struck me as most strange.

Some four years ago I had the privilege of reading to you a paper on memory, from which I will now quote: "When we attempt to acquire some new feat of manual dexterity, involving a series of combined muscular movements, such as a conjuring trick, we find that, when first attempted, each movement has to be thought out, and the whole is effected with difficulty. Every time that the process is repeated the action becomes more easy; each movement of the muscles involved follows its predecessor with greater readiness, and at last the trick becomes apparently one action, is performed without thought, and may be said to be automatic. The nerve structures involved have acquired a perfect memory of what is required of them; each takes up its part at the proper moment, and hands on in succession an intimation to its neighbor that it is time to transmit the expected impulse. Nerve centers have been educated. An organic memory has been established."

I went on to give instances in which, by frequent practice, actions had become so habitual as to take place on the application of the stimulus without the will of the individual, and even contrary to his wish. I gave as an illustration the story of the old soldier who was carrying a pie down the street, when some one mischievously crying "Attention!" down went the soldier's hands to his trouser's seams, and down went his dinner in the mud.

Let us apply this effect of constant practice to the case in question. The frog has a smooth, soft skin, unprotected by hair or scales. His haunts are stagnant water which swarms with injurious insects and other enemies; or the banks of ponds and streams abounding in sticks and stubs. From the time when the first progressive tadpole protruded his incipient legs, the race of frogs has been brushing away irritating substances. The nerve cells of their spinal cords have established such relations that, whenever a sense of irritation is conveyed to sensory cells, motor cells in connection are brought into action, and a complicated muscular movement follows, without the necessity of the interference of the will.

We may compare the association of nerve cells in the spinal cord to a group of men highly drilled in particular evolutions. Each individual cell of the group maintains relations with others near it by some one or more of its many arms. Upon the receipt of the intimation through sensory nerves and cells that there is, something burning a particular portion of the frog's skin, motor cells, accustomed to act with these sensory cells, send out messages to particular muscles. If the message is responded to, if the foot comes up and the offending particle is brushed away, the stimulus and the effort cease. If the stimulus still goes on, other cells which supply accessory muscles are called into play. If this effort to remove the offending matter is vain, and the irritation still goes on, the stimulus is passed on to other cells, which have in an emergency previously been in the habit of assisting; the stimulus thus travels to the opposite side of the spinal cord, and the other leg now comes up to the point required.

It is the effect of drill, of practice, in the forgotten past. I am aware that in making this statement I am assuming the inheritance of acquired powers—an assumption directly in opposition to the views of Weismann, who maintains that no powers acquired during the lifetime of the individual are transmitted to the progeny.

The development of the reflexes and instincts which we shall refer to, will be seen to be of such importance to the maintenance of the life of the individual or to the procreation of its race that the slow and gradual formation of nervous connections can probably be explained by the Weismann theory; but for our purposes to-night the assumption of the inheritance of acquired powers enormously increases the ease with which we can understand their development.

The idea of this paper is, therefore, that, as in the *individual*, constant habit causes in time such a free connection between nerve cells as to facilitate the passage from cell to cell of a particular stimulus until the action follows the stimulus automatically, so in the *race* a particular response to a particular stimulus has been repeated so often that the connection has become congenitally perfect, has become in fact what we know as a reflex. And, further, that the frequent repetition of particular actions under similar stimuli have so influenced the *intelligent* actions of the animal, that *they* also have become engrafted upon the nerve system, and recur under the influence of similar stimuli in an automatic manner; the result of these reactions of the intelligence to a particular stimulus being what we know as instincts.

The great advantage of a reflex is the certainty and usually the rapidity with which it acts. The response to the stimulus does not have to travel round through the brain. It takes a short cut. With imperfect reflexes the animal is at the mercy of its surroundings. Nature does not pass imperfect work. The eye reflexes, for instance, have been developed by constant practice. If through their failure an animal were partially blinded, some self-constituted factory inspector in Nature's workshop would soon get on the blind side of that animal, and there would be no chance of its perpetuating its failings. If the cough reflex failed, some septic fly would quickly start a fatal pneumonia.

Assuming that all reflexes have been developed by practice, it follows that our own are not merely aids to the diagnosis of disease at the hands of the physician, but are now, or have been, of use.

A year or two ago, in the British Medical Journal, there was a very interesting description of the strength of the reflex grip of the newly-born infant, this being sufficient to maintain the weight of the child for some minutes while hanging from a stick. This the writer attributed to the necessities of a time before perambulators, when a child had to hang on for bare life to its mother's hair or clothes. The inward-turned feet of the newly-born child and the plantar reflex point to a time when the feet were used for climbing and grasping.

Many of the superficial reflexes were probably developed to get rid of flies and other irritants which must constantly have troubled the naked body. The reflex action exhibited by the decapitated body, described at the commencement of this paper, was attributed by the observer to an attempt at self defense. I think it was more probably an attempt at scratching, an act which was probably habitual in our hairy ancestors, as it is now in our poor relations at the Zoo—a movement, in fact, strictly analogous to the movement of the frog's foot, incited by the irritation of the acid. To assume that there was an intention of defense in the action imports into the movement an element of consciousness for which, in the absence of the brain, we have no warrant; and this brings us to the question of instincts, which have been defined as reflex actions into which an element of consciousness has been imported.

I will endeavor to trace an ascending scale of instincts showing their dependence on reflex excitation. A newly-born infant has to be placed to the breast; it then seizes the nipple with its lips and sucks. There is little difference between the reflex action incited by the contact of the maternal nipple with the infant's mouth and the cough or sneeze reflex; both are complicated actions of many groups of muscles. In the one case, spasmodic; in the other, rhythmical. The young of the rabbit, born blind and helpless, muzzles about till it finds a nipple, and then takes its hold. The lamb, calf, or fawn, guided by sight and smell, *seeks* its mother's teat. In each of these cases a stimulus is required, either of touch, sight, or smell. Without the stimulus the experiment fails.

Fawns are peculiarly precocious. From the first they show a tendency to crouch and hide on the approach of danger. The following is an extraordinary instance of combination of maternal and infant instinct:

"I have had frequent opportunities," says the "Naturalist in La Plata," "of observing the young from one to three days old of the *Cervus campestris*, the common deer of the Pampas, and the perfection of its instincts at that tender age seems very wonderful in a ruminant. When the doe with fawn is approached by a horseman, even when accompanied by dogs, she stands perfectly motionless, gazing fixedly at the enemy, the fawn motionless by her side; and suddenly, as if at a preconcerted signal, the fawn rushes away from her at its utmost speed, and going to a distance of 600 to 1,000 yards, conceals itself in a hollow in the ground or among the long grass, lying down very close with neck stretched out horizontally, and will thus remain until sought by the dam. When very young it will allow itself to be taken, making no further effort to escape. After the fawn has run away, the doe still maintains her statuesque attitude, as if to await the onset; and when, and only when, the dogs are close upon her, she also rushes away, but invariably in a direction as nearly opposite to the fawn as possible. At first she runs slowly with a limping gait, and frequently pausing as if to entice her enemy on, like a partridge, duck, or plover when driven from its young; but as the dogs begin to press her more closely her speed increases, becoming greater the further she succeeds in leading them from the starting point."

In considering this case we have to remember that the deer is, as a rule, a woodland animal, and that its fawn, while feeble, crouches under cover, of which there is plenty within immediate reach; but the deer of the Pampas lives on rolling prairies, where the only cover is the isolated tufts of Pampas grass. While, therefore, the instinct to crouch is sufficient for the fawns of most deer, crouching in the immediate neighborhood of the surprise would be useless in the open ground of the Pampas; and this artful combination of tactics has doubtless been developed by practice.

In birds we get even more marked differences in connate powers and instincts, from the naked young of the sparrow, which is nearly as helpless as the human baby, to the newly-hatched chicken, which is a regular little man-about-town at once. The habits of the latter have been closely studied. Hatched out in an incubator, and deprived of all maternal instruction and example, he quickly begins to peck at all small objects, with a preference for moving ones, and from the first shows an almost perfect power of estimating distance and direction, which is very marvelous when we consider the great number of muscles which have to be co-ordinated in the act.

The late Mr. Douglas Spalding placed beyond question the view that all the supposed examples of instincts may be nothing more than cases of rapid learning, imitation, or instruction, but also proved that a young bird comes into the world with an amount and a nicety of ancestral knowledge that is highly astonishing. Thus, speaking of chickens which he liberated from the egg and hooded before their eyes had been able to perform any act of vision, he says that on removing the hood, after a period varying from one to three days, "almost invariably they seemed a little stunned by the light, remained motionless for several minutes, and continued for some time less active than before they were unhooded. Their behavior, was, however, in every case conclusive against the theory that the perceptions of distance and direction by the eye are the result of experience or of associations formed in the history of each individual life. Often, at the end of two minutes, they followed with their eyes the movements of crawling insects, turning their heads with all the precision of an old fowl. In from two to fifteen minutes they pecked at some speck or insect, showing not merely an instinctive perception of distance, but an original ability to judge and to measure distance with something like infallible accuracy. A chicken was unhooded when nearly three days old. For six minutes it sat chirping and looking about it; at the end of that time it followed with its head and eyes the movements of a fly twelve inches distant, at twelve minutes it made a peck at its own toes, and the next minute it made a vigorous dart at the fly, which had come within reach of its neck, and seized and swallowed it at the first stroke; for seven minutes more it sat calling and looking about it. For about thirty minutes more it sat upon the spot where its eyes had been unveiled without attempting to walk a step. It was then placed on rough ground within sight and call of a hen with a brood of about its own age. After standing chirping for about a minute, it started off toward the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after life. It never required to knock its head against a stone to discover that there was no road there. It leaped over the smaller obstacles that lay in its path and ran around the larger, reaching the mother in as straight a line as the nature of the ground would permit. This, let it be remembered, was the first time it had ever walked by sight."

In this experiment each movement of the chicken appears to have been started by an external stimulus. It pecked at the flies which it saw. It jumped or evaded the objects which it saw in its path. It remained stationary until its hereditary tendencies were stimulated by the sound and sight of the old hen in its neighborhood.

Mr. Spalding again says: "The art of scraping in search of food, which, if anything, might be acquired by imitation, is nevertheless another indubitable instinct. Without any opportunities of imitation, when kept quite isolated from their kind, chickens began to scrape when from two to six days old. Generally the condition of the ground was suggestive, but I have several times seen the first attempt, which consisted of a sort of nervous dance, made on a smooth table. Mr. Spalding, however, does not seem to have seen them scrape unless the ground was suggestive, and Dr. Allen Thompson hatched out some chickens on a carpet, where he kept them for several days. They showed no inclination to scrape because the stimulus applied to their feet was of too novel a character to call into action their hereditary instinct; but when Dr. Thompson sprinkled a little gravel on the carpet and so supplied the appropriate or customary stimulus, the chickens immediately began their scraping movements. Here, again, we see the hereditary instinct requiring a local stimulus to bring it about.

Mr. Spalding again says: "A young turkey, which I had adopted when chirping within the uncracked shell, was on the morning of the tenth day of its life eating a comfortable breakfast from my hand, when the young hawk in a cupboard just behind us gave a shrill chip, chip, chip. Like an arrow the poor turkey shot to the other side of the room, stood there motionless and dumb with fear, until the hawk gave a second cry, when it darted out at the open door right to the extreme end of the passage, and there, silent and crouched in a corner, remained for ten minutes. Several times during the course of that day it again heard these alarming sounds, and in every instance with similar manifestations of fear." Generations of young turkeys must in their native home have had cause to dread the cry of birds of prey; and the hereditary lesson had been well learned.

A water-bird was reared from the egg by another observer. It would swim freely, but he could not get it to dive by any means which he tried. One day while watching it in the water, a dog suddenly appeared on the bank. The necessary stimulus was applied; the hereditary reflex was set in action, and in the twinkling of an eye the bird had dived.

Handed down from generation to generation as these instincts have been, and impressed upon their owners by the imperative law that failure to inherit an instinct or a reflex meant death to the degenerate, these reactions persist long after they have failed to be of use.

As Dr. Louis Robinson has pointed out, the horse roamed, in a wild state, over plains of more or less long grass and low bushes. When a horse is alarmed, he throws up his head to get as wide a view as possible. The cow, on the other hand, keeps her head low, as if to peer under the boughs which covered the marshy grass of her jungle home. The horse's chief danger lay when, as he approached a stream to drink, he was liable to be sprung upon by a lurking lion; and to this day the two things that a horse dreads most are the rustling in bushes or reeds by the roadside and the wheelbarrow or tree-stump which his imagination depicts as a crouching enemy.

The dog once formed his lair in rough stuff, and now, when approaching sleep gives the accustomed stimulus, our pet dogs turn round three times upon the hearthrug to smooth down imaginary grass stubs. As an instance of an instinct which by its persistence under altered circumstances has become actually prejudicial, I may give the case of some shore-birds which had for many years nested upon flats covered with pebbles. As long as the pebbles remained, the eggs, which closely resembled them in markings, were rendered inconspicuous, but as the sea receded and grass grew, the pebbles became few and far between. The birds still, however, kept to their haunt, and actually collected pebbles around their eggs, thereby rendering their nests the more conspicuous.

In domestic fowls the habit of cackling as soon as they have laid an egg would certainly be detrimental to a wild race, and Hudson makes some interesting remarks on the modified habit in a semiferal race. The Creolla fowls, descended through three hundred years from the fowls introduced by the early settlers in La Plata, are much persecuted by foxes, skunks, etc., ever on the lookout for their eggs or themselves. These fowls in summer always lived in small parties, each party composed of one cock and as many hens

* A paper read before the Derby Medical Society.

as he could collect—usually three or four. Each family occupied its own feeding-ground, where it would pass a greater portion of each day. The hen would nest at a considerable distance from the feeding-ground, sometimes as far as four or five hundred yards away.

After laying an egg she would quit the nest, not walking from it as other fowls do, but flying, the flight extending to a distance of from fifteen to about fifty yards; after which, still keeping silence, she would walk or run, until, arrived at the feeding-ground, she would begin to cackle. At once the cock, if within hearing, would utter a responsive cackle, whereupon she would run to him and cackle no more. Frequently the cackling call-note would not be uttered more than two or three times, sometimes only once, and in a much lower tone than in fowls of other breeds. If we may assume that these fowls in their long semi-independent existence in La Plata have reverted to the original instincts of the wild *Gallus bankiva*, we can see how advantageous the cackling instinct must be in enabling the hen in dense tropical jungles to rejoin the flock after laying an egg, while if there are egg-eating animals in the jungle intelligent enough to discover the meaning of such a short subdued cackle, they would still be unable to find the nest by going back on the bird's scent, since she flies from the nest in the first place! It is obvious that while this form of cackling is useful, excessive cackling would in a state of nature lead to its own suppression.

We may suppose that as the wild fowl became more and more closely domesticated, the eggs of the greater cacklers were more rapidly found and preserved by their mistresses, and this tended to increase the tendency to cackle; while in the half-wild fowls of settlers who had plenty to do besides looking after their poultry there was a gradual reversion to the wild type by the elimination of the eggs of loud cacklers when not rapidly retrieved.

Birds which nest within a short distance of the ground display, as a rule, great skill in concealing their nests, and are very conservative in type. How is it that one chaffinch's nest is so like another's?

Gregarious birds like rooks have opportunities for learning by imitation, and may thus have lost some of their spontaneous skill. I have read somewhere that, when rooks were introduced into the Antipodes, young birds having been selected for transportation, they were found, when the breeding season came round, to be at fault, and finally imitated the nest of some native bird; but chaffinches build apart from one another; how, then, do they get their nests so nearly alike? A great observer has suggested that this is due to recollection on the part of the nesting pair of the home in which they were reared. This explanation does not commend itself to my mind, and is refuted, if not by the instance of the rooks just quoted, by the fact that tame canaries hatched in a nest of felt will, when they themselves breed, use moss for the foundation of their nest, and hair as a lining, just as a wild bird would do, although, as they build in a box, the hair alone would be sufficient.

If you want examples of what pure instinct can do, go to the insect world. There you get them in infinite variety. Hatched from the egg long after the death of the mother, the majority of insects have to depend entirely on the duly ordered reaction of their nervous organisms to stimuli similar to those which have for ages incited their forerunners.

The bot of horses has been hatched from the egg inside the stomach of its host. After some nine months' residence in the intestines, it is passed with the fæces and subsequently becomes the bot-fly. Until it becomes a perfect insect it has never seen the outside of a horse, and yet, as soon as it sees one, it knows exactly where to deposit its eggs in a position from which they can be licked off and swallowed in their turn. The sight and perhaps the smell of the horse is sufficient to inspire the hereditary desire to deposit eggs in a particular spot. If the stimulus and its reaction were insufficient, that particular bot-fly would cease to propagate.

The garden spider, again, hatched from an egg laid the previous autumn, brings an enormous amount of hereditary skill into the vicissitudes of its life. It selects its site, builds its web, adapts it according to the most approved plans to fortuitous circumstances, and distinguishes between harmless flies and dangerous wasps with an innate cunning which is an exact replica of the actions of the last year's brood. The nest of the trapdoor spider, too, is quite as wonderful a production as the nest of any bird.

Caterpillars, when they have reached their full growth, display great skill in selecting appropriate hiding places in which to pass into the chrysalis form, and those which weave cocoons do so in recognized stages. Huber has described one which makes, by a succession of processes, a very complicated hammock for its metamorphosis; and he found that if he took a caterpillar which had completed its hammock up to say the sixth stage of construction, and put it into a hammock completed only to the third stage, the caterpillar did not seem puzzled, but completed the fourth, fifth and sixth stages of construction. If, however, a caterpillar were taken out of a hammock made up, for instance, to the third stage, and put into one finished up to the ninth stage, so that much of its work was done for it, far from feeling the benefit of this, it was much embarrassed, and forced even to go over the already finished work, starting from the third stage which it had left off at, before it could complete its hammock. In this experiment it would appear that each instinctive action calls other actions in definite order, and unless the proper sequence is maintained the intelligence of the insect is unequal to bridging the gap.

Now let us apply the facts and inferences aforesaid to the nesting of the chaffinch. We have seen how habits acquired during the lifetime of the individual impress themselves upon the nervous connections, until, when the accustomed stimulus is applied, they become quite independent of the will. We have seen how certain reflex phenomena which are necessary for the life of the individual have, through congenital connections, become so automatic that they take place whether the brain is present or not. We have seen how habits of wild animals have, through similar nervous bonds, been handed down to tame descendants long after the said habits were useless and even detrimental. We have noted that ancestral habits may lie in abeyance until some perhaps unexpected stimulus arouses them—for instance, the scraping of chickens when placed upon gravel, or the diving of a water-bird upon sudden fright. We have ascertained that many of these instincts are certainly not due to instruction by older animals, but are purely spontaneous; that in insects these spontaneous actions are often most complicated, and are sometimes *not only* carried out in definite order, as in the weaving of their cocoons, but *cannot* be carried out except in that definite order.

The inference I draw is that the nest-building of the chaffinch is due to a succession of reflexes. You remember that when Alice was wandering about in Wonderland, she was continually coming upon medicine-bottles, marked "Drink me," or upon pieces of cake, marked "Eat me." You remember that when Alice obeyed these directions strange things happened. Alice was able to decipher her labels by the result of long and painful study in her nursery. Had they been written in the Cuneiform character, though perhaps perfectly intelligible to another, they would have conveyed nothing to her. The nervous system of the chaffinch has been educated by generations of hereditary experiences, and when the newly-wedded chaffinch pair start upon their housekeeping, they see in their mind's eye, upon some suitable site, a label marked "Build here"; they go through the stages of their architecture much as the caterpillar spins the different stages of its cocoon, each stage suggesting its successor; and each twig, hair, or feather which they use, bears upon it a label, "Use me next."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Business Methods in Europe.—The following extracts, from a letter written to me by the American Trading Company, of this city (Amsterdam), speak for themselves:

"One of the reasons for the small sale of American furniture and other manufactures in Holland and European countries in general is the slow delivery, owing to the absence of stock in the factories.

"We ordered, on February 12 of this year, a few gross of cots from a Wisconsin firm, and sold out in the meantime our old stock, expecting the new supply at the beginning of July. As we did not hear anything from the firm, we cabled in August and received a letter saying that the company would start work on our order. We had booked a number of orders from here and from Germany and France for these cots, and we cannot supply them.

"The same happened with office desks. Our desk man promised to ship the 400 desks ordered about August 10 to 15. At the end of August we received a cablegram to instruct our banker to pay against shipment documents. We cabled our New York banker the same day, but no desk has been shipped yet. These matters speak for themselves.

"As to European imitations of American specialties, we can state that they are not cheaper than American goods, and are of very bad workmanship. But we are sure, if we showed this people their faults and supported the home trade, they would work as well as manufacturers in the United States, and we would not need to send money three months before we saw the goods; on the contrary, we would pay three months after invoice.

"Again, we received 100 cash registers, which we dispatched directly from the steamer to a customer in Germany. Nearly all arrived broken, so that he refused the shipment. The goods are warehoused for our account in Germany; the German duty is paid, and we do not know what to do, because the goods were paid for a long time ago in America. The American manufacturer will not give us any allowance, and our German customer has the right to refuse the registers. This means a loss for us of about 6,000 florins ($2,400), and it does not encourage us to do further trade with that firm.

"We have had an offer from a British house to take goods on consignment. The managers propose to send us stock and to pay for all advertising. That would be the way for Americans to do business. United States manufacturers do not understand how to treat European dealers. We never receive the goods at the right time; we also think, if we give bankers' guaranty in New York, the manufacturers could take the risk of sending the goods payable against shipment documents in Holland, instead of New York.

"We do not think American exporters will ever be willing to send stock on consignment, but it would be to their interest to keep samples in Europe, and Amsterdam would be the right place, being on the seacoast and the center of a neutral country.

"We are sure, if we could keep a permanent exhibition of American goods here, large buyers of Europe would come to examine them, and much trade could be done. We would be prepared to give American manufacturers every security."

The fact noted in this letter—that the Netherlands is a "neutral" country—is very important. There is no identity of interest between the Netherlands and any other European country; consequently, her tariff system is not likely to be affected by any legislation on the part of her neighbors; and as she is not an industrial or manufacturing nation to any extent and her interests are almost exclusively commercial, her policy is not expected to be unfavorable to the entrance of American or any other imports.—Frank D. Hill, Consul at Amsterdam.

Under date of September 26, the consul adds:

I have received from Holcombe & Mulford, American merchants of New York and Amsterdam, a statement concerning American office furniture. Mr. Holcombe says:

"There are several American office-furniture houses doing business in this country at present. We are placing agents, working both here and in America, and are endeavoring to bring the manufacturer in touch with the wholesaler; in many cases arranging for sole agencies for a provisional length of time, with the understanding that at the expiration of said period the buyer will contract to take a certain amount from the manufacturer during the first year. A number of merchants here pay cash against documents or accept draft at thirty days' sight. Matters are greatly helped in the office-furniture business if a list of shipping weights is furnished the people here, and cubic measurements; in this case, the cubic schedule is most generally used. It is also of great value that prices be quoted c. i. f. Rotterdam. In catalogues, office furniture should be kept separate from other lines, as here they are distinct. Office furniture should not be too high priced, and all particulars should be given."

In the matter of introducing lumber from the United States, the same gentleman writes me:

"The entrance duty averages about 5 per cent. There is no differential duty on goods in bond or to be transshipped, and there is no occasion for transshipment, as there are several direct lines from the United States to Holland. I am confident that there is a good market here for certain kinds of lumber, if these can compete with German goods. Lumber comes into this country mostly in squares, and is resawed here."

The question of price is the prime consideration, Germany being able to land goods here cheaply.

Electric and Railway Developments in Korea.—On the night of August 17, the Seoul Electric Company formally opened its electric-lighting plant by turning on the power and illuminating the city by arc and incandescent lights. This lighting plant is run in connection with the electric street railway, the installation being of the polyphase direct-current alternating current system. I append a report on the plant from the contractors. The Seoul Electric Company is a Korean concern, but the builders and operators are American—Messrs. Collbran and Bostwick—who hold the plant on mortgage until all indebtedness is paid. This is not the first electric plant to be erected in Korea. In 1886, an Edison incandescent plant was installed in the palace, and was successfully operated until the boilers were worn out. In 1894 a new and very complete plant was erected by the American electrician of the Korean Government, Thomas W. Power, but the advent of the Japan-China war prevented its use for more than a short experimental period.

On August 20, at Yong Dong Po, just across the river from Seoul, on the line of the Seoul-Chemulpo Railway, work was begun in a formal manner upon the Seoul-Fusan Railway. This road, for which a Japanese company holds the concession, is to be 280 miles in length. It will connect Seoul with the southeastern port, and will pass through the rich agricultural region of southern Korea. The director informs me that some of the materials will be purchased in the United States. Persons wishing to communicate with the officers of the company in Korea may address the director, Mr. K. Takanouchi, Seoul, Korea, or Mr. Adachi, Chemulpo, Korea. It is expected that the road will be completed in six years. It will be of standard gage, and there will be considerable bridge work. It will be operated in connection with the Seoul-Chemulpo Railway, over whose tracks and bridge the new road will enter Seoul. The Seoul-Chemulpo road, with a ten-span steel bridge, is of American construction and equipment.

A railway to connect Seoul and the northwest border town, Weichu or Weiju, is being surveyed. This is to be built by French engineers, using French material. It will tap the coal and gold mining region and may at some time, if built, connect with Russian roads in Manchuria. At present, I am informed, that it is the intention to spend but 100,000 yen ($50,000) per annum upon it by the Korean Government. I believe there is some uncertainty as to where the necessary money is to come from. Mr. G. Lefevre, lately secretary of the French legation in Seoul, is director of this road. His address is Seoul, Korea.—Horace N. Allen, Minister at Seoul.

Brussels Sugar Congress.—Consul Covert writes from Lyons, September 23, 1901:

The sugar interests in France are giving a great deal of attention to the international sugar congress to be held in Brussels this fall. It is remarked that heretofore the fixing of bounties on the production of sugar was of importance to France, Germany, and Austria only; but as the output has been immeasurably increased within the last few years, other countries have become immediately interested in the subject. The output of sugar in France this year will probably be an increase over that of former years. The Economiste Français of September 14 reports the beet crop of European countries as very large, and quotes an immense stock on hand in England, "which, unfortunately," it adds, "has become almost our only customer." The same paper notes that the importations into England are very limited.

Italian Demand for Cellulose.—The Bureau of Foreign Commerce has received a letter from J. P. Spanier, 160 Corso Umberto, Rome, dated October 2, 1901, stating that he wishes manufacturers of cellulose (wood pulp) in the United States informed that he is desirous of receiving samples by mail, and prices c. i. f. Genoa. If quality and price are suitable, he can take several thousands of tons annually.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1173, October 28.—Administrative Reforms in China.

No. 1174, October 29.—Import Trade of Greece—German Industrial Conditions—New Russian Railroads—Arabian Wool Trade.

No. 1175, October 30.—American Coal in France—Charcoal in Marseilles—*Tobacco Culture in Haiti.

No. 1176, October 31.—*Acetylene Gas in Germany and Sweden.

No. 1177, November 1.—Trade Openings in Lourenco Marquez—Opening of Coast Trade in Morocco—Flax Spinning in Northern France—Cable Service to the Canary Islands—Moscow Trade with the United States: Correction.

No. 1178, November 2.—The Impending Crisis in European Sugar—Austrian-German Tariff Difficulties—New Mexican Railway—Nicaraguan-United States Treaties Terminated—*British Demand for Spectacle Frames—*Passenger Service between Odessa and Germany.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Preparation of Carbolineum.—Melt together 50 kilos of American resin (F) and 150 kilos of pale paraffine oil (yellow oil) and add, with stirring, 20 kilos of resin oil (rectified).—Neueste Erfindungen und Erfahrungen.

Ink Lozenges.—Same consist of Campeachy wood extract, mucilage and alum. These tablets dissolved in water furnish a serviceable ink. More simple are said to be pressed lozenges of black aniline substance.—Sueddeutsche Apotheker Zeitung.

Preparation of Tailor's Chalk.—Soak ordinary pipe clay in water and incorporate with it ultramarine for blue, finely ground ocher for yellow, burnt ocher for red, etc., until the mass is uniformly mixed. From this form pieces of suitable size, which are squeezed into oiled wooden or metal molds. After the molding, allow the pieces to dry slowly in the air or in moderately heated rooms, whereupon they are ready for use.—Neueste Erfindungen und Erfahrungen.

Production of Black Stain Proof to Acids and Lyes.—A black stain, which is not attacked by acids and lyes is produced by grinding 1 part of aniline black with a mixture of 60 drops of concentrated hydrochloric acid and 6 parts of alcohol. The deep-blue solution thus obtained is diluted with a hot solution of 1½ parts of gum arabic in 18 parts of water. The stain does not attack and is not destroyed by concentrated mineral acids or strong lyes. If the aniline-black solution is not thinned with gum water, but with a solution of 1½ parts of shellac in 4 parts of spirit, an aniline varnish is obtained which excels in exceedingly deep black color.

Salve for Removing Old Paint or Varnish Coats.—

I.

Sodium hydrate	2.5 parts
Soluble soda glass	1.5 parts
Flour paste	3.0 parts
Water	2.0 parts

II.

Barrel soap	5.0 parts
Potassium hydrate	3.5 parts
Potassium silicate	1.0 part

—Deutsche Maler Zeitung.

Production of Liquid Bottle Lac.—Place 250 grammes of shellac in a bottle holding about 2 kilos; pour 750 grammes of 96 per cent spirit and 75 grammes of sulphuric ether over it. Shake repeatedly until the shellac has completely dissolved and add 125 grammes of thick turpentine as well as 15 grammes of boracic acid, uniting all by agitation. For coloring, use spirit-soluble aniline colors as follows: Eosine for red, phenol blue for blue, aniline green for green, nigrosine for black and methyl violet for violet. If it is desired to render this varnish opaque, add 250 grammes of powdered soapstone, but in capping the bottles it is necessary to stir constantly, as the soapstone settles to the bottom very quickly.—Die Werkstatt.

Manufacture of Lime Salts by Means of Calcium Carbide.—(Process of M. HAUSER.) Calcium carbide being a substance thirsty for water, as soon as it is brought in presence of sodium carbonate, acid sulphate of hydrated sodium, or acid carbonate of hydrated sodium, it decomposes these salts. The carbon combines with the hydrogen contained to form acetylene. Lime carbonate or sulphate is then produced, according to the case, by the affinity of the lime contained in the carbide with the carbonate or sulphate contained in the salts employed, and the residue is soda in the state of caustic soda. When calcium carbide is brought in presence of the acid salts of fruits, lime tartrates, citrates, and oxalates are obtained which may readily be utilized by known processes. When it is put in presence of marine plants in the solid or moist state, which, on account of the moisture itself, act on the carbide to produce acetylene, as these plants contain alkali in combination with iodine, chlorine, and bromine, valuable remedies are obtained, such as alkalized chlorides, bromides, and iodides and cellular matter.—From the French.

Reduction of the Manganates of Baryta for the Purpose of Obtaining Barium Carbide and Metallic Manganese (Process of M. Limb).—The manganates of native baryta, called psilomelanes by the mineralogists, are manganese ores of inferior quality. They may be reduced by coal at a high temperature. The electric furnace may be employed, or any other arrangement securing the same temperature. Barium carbide and metallic manganese, more or less carbureted, are produced whose percentage of carbon depends on the proportions.

The employment of native ore is generally indicated, but the process can be applied to any industrial residue containing baryta and a manganese oxide. The barium carbide may be sold as such, or may be decomposed by water, which produces caustic baryta and acetylene. The latter may be delivered in cylinders under pressure, or free; or, still better, dissolved in acetone. It may also be converted into acetylene black, or into various products by synthesis.

The cast manganese may remain for use as it is, or be refined by heating with manganese oxide and lime, as M. Moissan has indicated, or, more simply, with the ore itself, which contains both the oxide and baryta. Before treating the ore it is quite advantageous to calcine it in order to remove the oxygen which it may yield; this is now utilized in commerce. In this way less coal is necessary for the reduction. It is scarcely possible to state proportions. The psilomelane being a mineral of very variable composition, a quantitative analysis of the ore would be necessary, either before the calcination if the oxygen is to be removed or afterward. The baryta and the oxygen combined with the metal are determined. The proportion of coal is easily ascertained by considering that for 100 parts of baryta 23.5 parts of carbon are necessary, and for 100 parts of oxygen 75 parts of carbon.

If desired a small quantity of coal can be added for carbureting the manganese more or less, which, according to M. Moissan, will thus volatilize more readily.—From the French.

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